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USSR Report

MATERIALS SCIENCE AND METALLURGY

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USSR REPORT

MATERIALS SCIENCE AND METALLURGY

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ALUMINUM AND ITS ALLOYS

UDC 539.43:539.376

EFFECT OF DEEP COOLING ON CRACK RESISTANCE AND LOW-TEMPERATURE HARDENING OF ALUMINUM ALLOYS

Kiev PROBLEMY PROCHNOSTI in Russian No 11, Nov 84 (manuscript received 2 Jul 84) pp 27-32

PISARENKO, G. S., STRIZHALO, V. A., ZNACHKOVSKIY, O. Ya and NOVOGRUDSKIY, L. S., Institute of Problems of Strength, UkSSR Academy of Sciences, Kiev

[Abstract] Thin-walled designs commonly used in cryogenic technology for bearing components or for storage and transportation vessels require special durability and brittleness qualities. The present article reports on a study of aluminum-copper alloys, nickel and austenite steels with high nickel content to establish temperature factors affecting durability, and crack resistance in particular. Tensometric sensors and resistors were used to measure load and deformation. Cooling was done with liquid nitrogen or liquid helium, or their vapors. The alloys tested were AMg5 and AMg6 (aluminum-magnesium) and AMnS (aluminum-manganese). The samples were cylindrical with a diameter of 4 mm and a 20 mm working surface, and compact samples with a 12 mm thickness. Tests were made at 293, 178, 77 and 4.2°K at a movement of 5 mm/min. Results indicated that aluminum's resistance to cracking changed with temperature reduction, increasing at 178 and 77°K, then decreasing somewhat as the temperature approached absolute zero (4.2°K) The net result was little difference in durability at 293°K and at 4.2°K, indicating the possibility of using the alloys for low-temperature applications. Figures 5; references 9: 7 Russian, 2 Western.
[69-12131]

UDC 532.593

KINETICS OF SPLITTING FRACTURE OF AMg6M ALUMINUM ALLOY

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKIKH FIZIKI in Russian No 5, Sep-Oct 84 (manuscript received 24 Jul 83) pp 60-64

KANEL', G. I., RAZORENOV, S. V. and FORTOV, V. Ye., Chernogolovka

[Abstract] Specimens were made from sheet materials 1.8-10 mm thick. Pulses of compression were generated by aluminum foil impact at 675 ± 15 m/s upon detonation of an explosive charge in contact with the specimen. The velocity profile of the free back surface of the specimens was recorded by capacitive sensors. A continual model of fracture under these conditions suggested in an earlier work is modified on the basis of the recorded characteristics.
[71-6508]

UDC 669.539.43

FATIGUE OF CLAD ALUMINUM MATERIALS D16T AND 2024-T3 WITH STEPPED LOADING

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 20, No 6, Nov-Dec 84 (manuscript received 6 Jan 84) pp 87-88

YUSTERN, MAMBVE, and RADCHENKO, A. I., Kiev Institute of Civil Aviation Engineering

[Abstract] Specimens of aluminum alloy D16T and the similar American alloy 2024-T3 were used in studies of two-step cyclical loading. The two materials were covered with a cladding layer. The composition of the materials is similar, but 2024-T3 is not only hardened but also cold deformed, which improves its strength properties. Tests were performed in symmetrical cantilever bending at 50 Hz in an electromagnetic installation. It was found that the variation in residual durability as a function of preliminary loading was not monotonic for either material, having a number of extreme points, the distance between which remains constant with an increase in preliminary loading. The results of the tests confirmed the correctness of the discrete probability model of fatigue failure with various stress states of specimens. The universal fracture constant defined for pure metals was found to be suitable for calculation of cyclical durabilities of aluminum based alloys. Figures 1; references: 3 Russian.
[86-6508]

AMORPHOUS METALS

UDC 669.25:779:539.213:539.143.43

DETERMINATION OF SYMMETRY OF IMMEDIATE SURROUNDINGS IN AMORPHOUS Co-P ALLOYS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 58, No 6, Dec 84 (manuscript received 10 Feb 84) pp 1214-1215

ISKHAKOV, R. S., FISH, G. I., MAL'TSEV, V. K. and KHLEBOPROS, R. G., Institute of Physics imeni L. V. Kirenskiy, Siberian Branch, USSR Academy of Sciences

[Abstract] The purpose of this work was to demonstrate that the close order symmetry of amorphous Co-based alloys can be determined by nuclear magnetic resonance in studies of concentration variation of NMR spectrum characteristics. The objects of the study are Co-P alloys obtained by chemical precipitation, containing from 1 to 14 at.% P. As the concentration of phosphorus decreases, the frequency corresponding to the spectral maximum approaches 227 MHz, the NMR frequency of crystalline hexagonal close-packed Co. At about 5 at.% there is a sharp change in the variation of frequency and 2 Δf related to a change in symmetry of the crystalline solid solution. At greater concentrations, over 6 at.%, the experimental points for maximum frequency fall on a straight line. Extrapolation of the line to the ordinate yields a value of 214 ± MHz for maximum frequency. The frequency of 216 MHz for face-centered cubic crystalline Co falls within the confidence interval of the initial ordinate of the line. The lack of anomalies in concentration variation of maximum frequency on 2 Δf at over 9 at.% indicates that the close order symmetry does not change upon concentration transition of the crystalline solid solution to an amorphous state. Thus, amorphous Co-P alloys have face-centered cubic near-order symmetry. Figures 2; references 4: 2 Russian, 2 Western.
[85-6508]

UDC 669:539.2/3

STRUCTURE OF Co_2Ge ALLOY IN GLASSY AND LIQUID STATES

Moscow IZVESTIYA AKADEMII NAUK SSSR: NEORGANICHESKIYE MATERIALY in Russian Vol 20, No 11, Nov 84 (manuscript received 1 Mar 83) pp 1829-1833

MASLENNIKOV, Yu. I., Ural Polytechnic Institute imeni S. M. Kirov, and SUDAKOVA, N. P. Sverdlovsk Institute of National Economy

[Abstract] The structure of the Co_2Ge alloy, glassy and liquid, was examined for short-range order by analysis of the radial distribution of atoms. The conclusions of this study are based on comparison of theoretical models of structural factors with experimental data on the structural factor $\alpha(s) = i(s) + 1$, including the height of the first i(s) peak (area under the maximum of the radial distribution function) as well as the locations and the forms of successive peaks along with the logarithmic decrement. Glassy films of cobalt germanides Co_2Ge, CoGe, $CoGe_2$ for the experiment were prepared by thermal sputtering of presynthesized alloys from a conical tungsten helix on varnish substrates cooled under vacuum to liquid-nitrogen temperature. The results indicate that the distribution of atoms in glassy Co-Ge alloys becomes fairly uniform over the coordination spheres, with the packing factor increased by approximately 8% and the interatomic distances correspondingly decreased. Localization of interaction between different atoms and absence of a short-range order impede crystallization and facilitate amorphization during quenching. Subsequent annealing produces first an unstable quasi-crystalline disordered intermediate b.c.c. structure of short-range order and substitutional kind, then an ordered "superstructure" of intermetallic compounds. Figures 1; references: 11 Russsian.
[46-2415]

UDC 669.15'25'782'781:539.213:538.67

INFLUENCE OF INITIAL STATE ON KINETICS OF INDUCTION OF UNIAXIAL MAGNETIC ANISOTROPY IN AMORPHOUS $Fe_5Co_{70}Si_{15}B_{10}$

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 58, No 2, Aug 84 (manuscript received 12 Jul 83) pp 403-405

KEKALO, I. B., ZHDANOV, A. N., TSVETKOV, V. Yu., Moscow Institute of Steel and Alloys

[Abstract] Previous works have shown a decrease in the rate of change of the uniaxial anisotropy constant as a result of preliminary annealing. However, the question as to whether preliminary annealing influences only the kinetics of change in the constant K_u or whether it may change its limiting value, as well as the question of the specifics of the influence of high-temperature and low-temperature preliminary annealing, remain open. This

work is dedicated to answering these questions. To this end, studies were performed on the alloy $Fe_5C070Si_{15}B_{10}$ with almost zero magnetostriction. The alloy was obtained as a strip 1 mm wide by hardening from a melt on a rapidly spinning disk. The crystallization temperature is about 500°C, the curing point 370°C. The strip was wound on a quartz coil 1.5 cm in diameter to measure its magnetic properties. Static hysteresis properties were studied. Annealing was performed in a longitudinal magnetic field of 0.8 kA/m, as well as a transverse field of 560 kA/m. It is found that at 250°C the process of stress relaxation is much stronger than the liberation of excess free volume. Structural changes in the amorphous matrix of the alloy are found to be related to the relaxation of internal stresses and reversible compositional ordering, strongly influencing its maximum value. Structural changes accompanying the liberation of excess free volume also influence both kinetics and limiting value of constant K_u. Figures 3; references 5: 3 Russian, 2 Western.
[010-6508]

UDC 669.017.1:539.213:537.311.31

TEMPERATURE VARIATION OF RESISTIVITY OF CERTAIN ALLOYS BASED ON TRANSITION AND SIMPLE METALS IN AMORPHOUS AND CRYSTALLINE STATES

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 58, No 2, Aug 84 (manuscript received 23 Dec 83) pp 292-297

GUMBATOV, S. G., PANOVA, G. Kh. and SHIKOV, A. A.

[Abstract] A study is made of the temperature variation of resistivity of the amorphous systems $Zr_{70}Be_{30}$, $Zr_{60}Be_{40}$, $Hf_{58}Be_{42}$, $Zr_{75}Rh_{25}$, $Zr_{54}Cu_{46}$, $Mg_{70}Zn_{30}$ and their crystalline analogs in the 4.2-300°K temperature range. All of the systems have a single phase in the metastable crystalline state, with second phase content of $Zr_{54}Cu_{46}$ not over about 4%. Resistance behaves anomalously in amorphous specimens, dropping by 4 to 6% with an increase in temperature from 4.2 to 300°K. The temperature variation of the specimens can be described within the framework of the theory of liquid metals, in which the temperature variation of the structural factor explains the existence of a negative temperature coefficient of resistance. The crystalline analogs of the amorphous systems have the traditional positive variation of coefficient of resistance. Figures 4; references 19: 4 Russian, 15 Western.
[010-6508]

UDC 669.017:539.213

CONVERSIONS IN AMORPHOUS ZIRCONIUM-VANADIUM ALLOY

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 278, No 2, Sep 84 (manuscript received 26 Jan 84) pp 348-350

BARMIN, Yu. V., VAVILOVA, V. V., GALKIN, L. N., ZOLOTUKHIN, I. V., KOVNERISTYY, Yu. K. and RUDA, G. I., Metallurgical Institute imeni A. A. Baykov, USSR Academy of Sciences, Moscow

[Abstract] Amorphous V-Zr alloys have been produced by spraying methods. The present article reports on quenching from a gaseous phase in order to study phase conversions and thermal durability. Very thin foil was prepared at 293°K, producing evenly distributed components which were then studied by x-ray, electron diffraction and differential thermal analysis. The diffractogram showed a single diffusion halo from the sample. The attempt to produce an amorphous foil alloy failed, since a polycrystal of metastable finely dispersed phase grains of 3.0 nm size emerged. Thermal analysis after gradual heating to 1123°K revealed exothermal effects at 848, 888, 948 and 993°K. These changes were attributed to changes in topological structure that approached the desired amorphous structure. Retaining the sample at 573°K for 1 hour after gradual heating reduced all conversion temperatures, while heating to 1123°K, brought crystallization and emission of V_2Zr and alpha-Zr. Bonding began to weaken above 723°K and internal friction changed above 593°K. The alloy had 49.3% Zr by weight. Figures 2; references 7: 3 Russian, 4 Western.
[25-12131]

UDC 669:539.2/3

STRUCTURE AND AGING OF AMORPHOUS CHROMIUM-GERMANIUM ALLOYS

Moscow IZVESTIYA AKADEMII NAUK SSSR: NEORGANICHESKIYE MATERIALY in Russian Vol 20, No 11, Nov 84 (manuscript received 1 Mar 83) pp 1834-1838

MASLENNIKOV, Yu. I., Ural Polytechnic Institute imeni S. M. Kirov, and SUDAKOVA, N. P., Sverdlovsk Institute of National Economy

[Abstract] The radial distribution of atoms $g(r) = \rho(r)/\rho$ in Cr-Ge alloys was established experimentally, on the basis of the structural factor $\alpha(s) = i(s) + 1$, with the aid of Fourier transformations. Model functions of this distribution were subsequently constructed on the basis of simple b.c.c. and c.p.h. lattices with a packing factor $\eta = 0.64$ and a density corresponding to that of the amorphous phase. Structural factors were then calculated according to the discrete Debye equation, after redistribution of atoms over coordination spheres, whereupon the results were compared with measurements. Amorphous films of chromium germanides Cr_3Ge, Cr_3Ge_2, CrGe for the experiment

were prepared by thermal sputtering of presynthesized alloys from a conical tungsten helix on varnish substrates cooled under vacuum to liquid-nitrogen temperature. Strong interaction of the components, owing to their nearly equal vapor pressures, produced homogeneous alloys. The amorphous Cr_3Ge compound was found to have a structure characterized by an irregular close packing of different atoms. The initially quasi-crystalline disordered b.c.c. structure with a short-range order and of the substitutional kind transformed, upon annealing, into an ordered "superstructure" of the intermetallic compound with a β-W (A-15) lattice. The other two intermetallic compounds were found to have microheterogeneous structures, but without ordering of friable germanium. Figures 1; references: 10 Russian.
[46-2415]

UDC 538.632.001

THEORY OF ANOMALOUS HALL EFFECT IN AMORPHOUS FERROMAGNETIC MATERIALS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 58, No 6, Dec 84 (manuscript received 8 May 84) pp 1084-1092

VEDYAYEV, A. V. and GRANOVSKIY, A. B., Moscow State University imeni M. V. Lomonosov

[Abstract] An equation is derived for the anomalous Hall effect coefficient in amorphous ferromagnetic alloys based on transition 3d metals. The specifics of asymmetrical scattering of anomalous Hall effect carriers in amorphous systems resulting from the absence of spatial periodicity and placement of atoms are studied. References 19: 10 Russian, 9 Western.
[85-6508]

UDC 539.213:538.221

STUDY OF AMORPHOUS STRIPS AND MICROCONDUCTORS BY FERROMAGNETIC RESONANCE METHOD

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 58, No 6, Dec 84 (manuscript received 14 Apr 84) pp 1144-1147

POKATILOV, V. S., KAPEL'NITSKIY, S. V., OVCHAROV, V. P., KULAGIN, B. N. and ZAKHAROVA, L. K., Institute of Precision Alloys, Central Scientific Research Institute of Ferrous Metals imeni I. P. Bardin

[Abstract] The ferromagnetic resonance method was used to study amorphous ferromagnetic alloys based on Fe, Co and Ni. The saturation magnetization and g-factor were computed for strip specimens from data on the resonant field with perpendicular and parallel placement of the plane of the specimen

relative to a constant external magnetic field. The reasons for differences between strip and wire specimen values of ΔH are studied. The heterogeneity of the effective field arises due to macroscopic heterogeneity of the demagnetizing fields in the strip. The structure of the amorphous strip is essentially heterogeneous. The inversely proportional variation in ferromagnetic resonance line width as a function of magnetization and the values of relaxation parameter for amorphous alloys are similar to those observed earlier for perfect ferromagnetic single crystals. Figures 2; references 9: 4 Russian, 5 Western.
[85-6508]

UDC 669.85/.86.018:539.213:538.652

MAGNETOSTRICTION OF AMORPHOUS ALLOYS OF RARE EARTH METALS WITH IRON AND COBALT

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 58, No 6, Dec 84 (manuscript received 28 Jul 83; in final form 3 Apr 84) pp 1132-1136

NIKITIN, S. A., ANDREYENKO, A. S., KAZANTSEV, V. G., KOTUNOV, V. V. and NAM, B. P., Moscow State University imeni M. V. Lomonosov

[Abstract] Results are presented from studies of magnetostriction and magnetic properties of the rare earth amorphous alloys $TbFe_2$, $SmCo_5$ and Sm_2Co_{17} at 4.2 to 300°K in fields of up to $40 \cdot 10^5$ A/m. Studies were performed on specimens obtained by ion plasma atomization onto a cold substrate. Specimens were plates measuring 10 x 10 mm and up to 1 mm thick. All specimens studied were x-ray amorphous. At 4.2°K an amorphous alloy $TbFe_2$ yields a magnetostriction at $40 \cdot 10^5$ A/m of $770 \cdot 10^{-6}$, somewhat less than in a polycrystalline alloy of the same composition. Magnetostriction is thus only slightly less than the magnetostriction of analogous crystalline compounds. It is concluded that magnetostriction results primarily from deformation due to the interaction of the anisotropic 4f electron shell of rare earth ions with the electrostatic field of neighboring atoms. Figures 3; references 9: 4 Russian, 5 Western.
[85-6508]

UDC 539.23:548.5

CRYSTALLIZATION OF AMORPHOUS NIOBIUM OXIDE FILMS DURING VACUUM ANNEALING

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian, No 6, Nov-Dec 84 (manuscript received 28 Sep 82) pp 86-91

SOKOL, A. A. and D'YAKONENKO, Yu. P., Khar'kov

[Abstract] A study is presented of the variation in annealing of amorphous Nb_2O_3 films in a vacuum, intended to determine at which temperatures crystallation begins, what modifications arise and how the chemical composition of amorphous films changes in the process of annealing. Amorphous Nb_2O_5 films were placed on nickel object screens and annealed in a vacuum chamber at $10^{-3} - 10^{-7}$ Pa at 200-600°C or 1000-2000°C. At 300-400°C, oxygen is liberated. The rate of oxygen liberation is increased by 2 or 3 orders of magnitude at 1000-2000°C. Even under the most favorable conditions, the oxygen content of the film does not decrease below NbO_2, indicating that some 20% of the oxygen contained in a film of Nb_2O_5 is weakly bonded. Vacuum annealing is capable of producing oxides with stable chemical composition. Figures 1; references 9: 6 Russian, 3 Western.
[51-6508]

COATINGS

UDC 621.793.8

PRINCIPLES OF CREATION AND SPECIFICS OF FORMATION OF EUTECTIC COATINGS FROM LIQUID PHASE

Kiev FIZIKO KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 20, No 6, Nov-Dec 84 (manuscript received 29 Nov 83) pp 25-29

GOLUBETS, V. M. and PASHECHKO, M. I., Institute of Physicomechanics imeni G. V. Karpenko, Ukrainian Academy of Sciences, L'vov

[Abstract] A study is presented of the specifics of diffusion surfaced eutectic coatings of over 1 mm thickness from powdered mixtures onto steels. The specifics of formation of a coating, including formation of a liquid phase on the surface at the eutectic melting temperature of the surface layer of the metal and components of the powder mixture, with at least one component forming a eutectic with the metal being coated at that temperature present in the powdered mixture, were studied on the example of a mixture containing 20-22 mass % grey cast iron, 23-25 mass % ferromanganese, 10-15% sodium fluoride, remainder boron oxide. A specimen of type 45 steel with the base mixture applied was placed in a furnace which had been preheated to 1553°K, achieving heating at 283 K/s. The mixture on the specimen was 5 mm thick, held in the furnace for 8 minutes at 1553°K, then cooled in air. The coating received was 2.5 mm thick, microhardness of various phases 5-9 GPa. X-ray structural studies showed an increase in the content of manganese, boron and carbon in the coating in comparison with the body of the steel. The steps in the process of formation of the eutectic coatings are noted. Figures 2; references 14: 12 Russian, 2 Western.
[86-6508]

UDC 669.22:533.9

STRUCTURE AND PHYSICAL-MECHANICAL PROPERTIES OF PLASMA-ATOMIZED ALUMINUM

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian, No 6, Nov-Dec 84 (manuscript received 30 Mar 83) pp 80-85

SHORSHOROV, M. Kh., KUDINOV, V. V., KALITA, V. I., BETSOFEN, S. Ya. and VERNIKOVSKIY, B. K., Moscow

[Abstract] A study is made of the structure and properties of plasma atomized coatings with aluminum oxide content not over 1%. Type AD1 alloy with various heat treatments before cold rolling was studied. Three stages were found in the curve detecting variation in microhardness of the material as a function of degree of deformation by cold rolling: elimination of porosity, hardening and dynamic recovery. Regulation of the phase state of the hardening phase and structural defect density can increase the yield point of the material from 40 to 310 MPa. Figures 3; references 21: 11 Russian, 10 Western.
[51-6508]

UDC 539.512:669.017:539.533

MICROHARDNESS OF THIN PLASTIC COATINGS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian, No 6, Nov-Dec 84 (manuscript received 23 Sep 82) pp 128-133

SHIRSHOROV, M. Kh., BULYCHEV, S. I., KULAPOV, A. K., KRAVCHENKO, V. I. and FEDYUNINA, A. S., Moscow

[Abstract] Measurement of microhardness in thin plastic coatings 0.4—2 μm thick by ordinary methods is virtually impossible. Therefore, the authors of this work use a method of kinetic microhardness measurement, in which continuous measurements are made with high accuracy beginning at zero depth of indentation of the indenter. A diagram of load on indenter versus depth of impression is recorded with an accuracy of $5 \cdot 10^3$ mm/N for load, 35 mm/μm for depth of impression. Studies were performed on aluminum coatings 0.4—2.16 μm thick atomized onto silicon plates at a vacuum of $1 \cdot 10^{-4}$ Pa. Some sources of error in the method are discussed. An equation is presented for the variation in surface microhardness, with the coating thickness being equivalent to grain size. The variation of microhardness with depth is analyzed as a function of coating thickness. The variation is found to be determined by deformation hardening of the coating, indenter tip geometry and the difference in microhardness of coating and substrates. Figures 4; references: 4 Russian.
[51-6508]

COMPOSITE MATERIALS

OUTLOOK FOR POLYMER COMPOSITE MATERIALS

Moscow KRASNAYA ZVEZDA in Russian 8 Dec 84 pp 3-4

[Article by Yuriy Sergeyevich Lipatov, academician, UkSSR Academy of Sciences, appears under the rubric: "These Remarkable Composites"]

> [Text] Machine building and aviation, space technology and electronics, medicine, agriculture and many others are inconceivable today without the use of polymers. It suffices to say that plastics are second only to metals in volume production. Predictions show that plastics may be in first place by the end of the century. In time, there will be an even greater need for plastics. This is why the development of new materials with specified properties, known as polymer composites, is one of the most important tasks of science.
>
> What are polymer composites? How are they "constructed"? In the future what can be expected in the development of polymer material research? The editorial staff has asked UkSSR Academy of Sciences Academician, Yuriy Sergeyevich Lipatov, director of the Institute of Chemistry of High Molecular Compounds, UkSSR Academy of Sciences, to respond to these questions.

Mankind has been using polymer materials, based on organic compounds of an extremely high molecular mass, in everyday practice for a long time. Caoutchouc, wood, fibers and adhesive substances were already known in ancient times. The same can be said about composition materials. Clay products and bricks which appeared about 5000 B. C. are often more complex "materials" than they may appear to be at first glance.

Here are specific examples. Crushed stones were often added to clay to reduce shrinkage and cracking during baking. Materials based on reinforced bituminous resin were used in construction. There is information that about 3000 B. C. river vessels were

made of reed, saturated with bitumen, in Egypt and Mesopotamia. They may be considered the predecessors of modern fiber glass launches and boats. In 1000 B. C. bows were made of a composition material, based on wood and layers of horn, in Western Asia and China. Composition materials have been used to make the barrels of Damascan guns, Japanese ceremonial swords and...

Our 20th century is characterized by a special relationship to materials of this type. The production of plastics, synthetic and artificial fibers, synthetic rubbers and leathers, protective coatings and others, based on polymers, has become one of the most important trends in technological progress.

What are polymer composition materials or polymer composites? So far, there has been no clear, generally accepted definition. This is explained to a certain extent by the fact that plastics themselves are already compositions, which contain in their composition, in addition to the basic polymer substance, different additions--plasticizers, stabilizers, fire retardant substances, and others. Nevertheless, it is characteristic for combinations of different substances from which a new material, more complex in structure and with a new combination of properties, is produced that its components retain their individual characteristics.

The general appearance of the structure of a composition material may be visualized as one polymer phase (matrix) and one or several dispersed phases (fillers), which are distributed in a specific manner in this matrix.

The number of potential combinations of the different substances is great. This means that we can produce the most incredible, seemingly, materials. With fantastic properties! An important factor, which determines the properties of a material, is the chemical and physical processes that lead to an interaction of the components at their interface. When we learn how to control these interactions, then we will be able to produce composition materials with any, specified beforehand, properties.

However, everything is not so simple. To solve the problem, it is essential to know well with what components we are dealing, which of their properties ensure the strength of the material, and which components are important from the viewpoint of interphase interactions, ensuring the realization of these properties. As an example, let us take such a widespread reinforcing filler as fiber glass. The main advantages of fiber glass over other fillers are high mechanical strength, chemical stability, and availability of the initial raw material. And, its production is not a complicated matter: a thin thread is extruded from molten glass at a high speed (about 2 kilometers per minute). At the present time, quartz and silicon fibers are increasingly used in the development of reinforced building materials. Products made of such materials operate normally at temperatures of 1200-1300 degrees.

Organic synthetic fibers are widely used as a reinforcing material. The construction materials that are produced based on these fibers have high tensile strength and high elasticity. A few words about carbon fibers. They differ in that they have a remarkable resistance to high heat. Their strength and elasticity in an inert medium practically do not change up to 2000-2200 degrees.

Boron threads are one of the most promising high strength materials. This is a monofiber with a 50-200 micron diameter that is produced by precipitating boron from a gas mixture of hydrogen and boron trichloride on a heated tungsten wire with a 12.5 micron thickness. As a result of precipitation, a core with a 15-17 micron diameter is formed from the tungsten borides and a layer of polycrystalline boron around it.

Systems that contain at the same time two or more types of fibers --glass, organic, carbon and boron--are very promising for the production of composites. Hybrid composites are produced by using several types of reinforcing fillers. Such technology expands the potentialities for producing materials with specified properties.

Thus, the purpose of reinforcement is to obtain a stronger polymer material. However, strengthening may also be attained by introducing so-called finely-dispersed fillers: particles of inorganic substances, for example powdered quartz and other minerals (chalk, talc, kaolin, mica and ground fiber glass). The entire complex of physico-mechanical properties of developed materials may be improved with the introduction of dispersed fillers. Some of the fillers may impart to a material such desirable properties as reduction of mass, change of heat conductivity and electroconductivity, and others.

Bonding of the reinforcing fibers or other elements into a single monolith is the basis for developing composition materials. In other words, we are talking about bonding these elements with polymer binders. The properties of the composition material itself depend largely on these binders. The binding substance should ensure maximum adhesion (bonding), high strength, uniform distribution of forces between the reinforcing elements, heat resistance and other qualities.

Polymer composition materials are widely used in all branches of the national economy. Their use is particularly successful in machine building, aircraft and automobile industries, ship building, in developing aerospace technology... Composites have proven to be good antifrictional or frictional materials, used mainly for production of frictional details--gears, cams, brakes, clutches and bearings.

For example, bearings based on filled thermoplastic materials display a lower wear rate compared to bronze, quieter movement, and

no need for lubrication during operation. Let us take such complex operations as repair of vessels that are afloat! Binding substances have been developed in our institute that enable the repair of vessels under any atmospheric conditions, with liquid oil contamination of surfaces, as well as underwater. The development of these binders and the fiber glass plastics based on them has enabled us to ensure high strength and resistance to vibration in combining such fiber glass plastics with metal, and to ensure resistance to impact loads.

The use of polymer composition materials in aircraft construction allows for a 10-20 percent weight reduction of separate highly loaded structures. Use of these materials is very promising as "strengthening" for metal structures when improved strength and rigidity are needed.

Composition materials are also widely used in the manufacture of pipelines, reservoirs and tanks for storing petroleum and chemical products. Mine timbering and other equipment for mining operations are made of composites. Polymer binders are used to strengthen soils and to improve the rigidity of wood when restoring crumbling masonry.

Semitransparent roofing in the form of corrugated sheets of different colors is manufactured from glass mats, saturated with polyester resin binders. They are strong and light, and this allows us to reduce the mass of load bearing structure elements. Fiber glass materials may be used for the manufacture of large scale panels and slabs for walls and floors, angles and beams of different profiles, reinforcement for stressed concrete, plinths, cornices, bathtubs, sinks and other sanitation equipment. Polymer composition materials successfully imitate valuable natural minerals: jasper, malachite and others.

The production of plastics and synthetic resins will be 6-6.5 million tons by the end of the 11th five-year plan. On this basis, more than 300 types of new plastics are planned to be put into production, as well as over 2.5 thousand descriptions of products for the equipment list of motor vehicles, electrical machines, and radio engineering and electrical engineering units. The output of chemical fibers and threads will be increased to 1.6 million tons.

What may we expect from science in respect to polymers at the end of this century? New materials will be developed--nonflammable, with a high resistance to high temperature action and a rubber-like elasticity at temperatures close to zero. We may expect that we will succeed in accelerating by many times the technological processes themselves for the production of new materials with specified properties. Medicine is expecting from us composites with physiologically active and medicinal actions, as well as

polymer materials for making an artificial heart and kidneys and for "replacement" of human skin with burns.

The potentialities for polymer materials to be information carriers are great. I think that, in the not-too-distant future, a film will be developed on which a million bytes of information may be stored in one square centimeter! Synthetic polymers may also be given such properties that they will become substitutes for natural food products. New food products, based on polymers, with good taste qualities will appear in the future.

We can expect a change in the consumption structure of polymer materials and a "reexamination" of the raw material sources for their synthesis. As oil and gas resources dwindle, mankind will learn to produce polymer materials of an inorganic nature. It is then that the unseen perspectives for using the remarkable properties and characteristics of polymer composition materials with properties, which are now present only in organic polymers, will be discovered.

And, our 20th century is a century of grandiose achievements in science and technology. Just what names hasn't it been given? "The century of electricity", "the century of nuclear energy", "the space century", "the century of electronic computers"... Among the names there is this one--"the century of synthetic polymer materials". And, this makes much sense.

Life often disproves the prognoses that seem most real. We certainly do not know what the 21st century will be like. And yet, we can say with certainty: the age of polymers, which has started in this century, will continue its life and, possibly, will attain its real development only in the future.

12525
CSO: 1842/58

RESEARCH,DEVELOPMENT OF COMPOSITE MATERIALS DESCRIBED

Minsk SOVETSKAYA BELORUSSIYA in Russian 27 Nov 84 p 3

[Article by A. Sviridenok, director of the Institute of the Mechanics of Metal and Polymer Systems of the BSSR AN [Academy of Sciences] and a Corresponding Member of the BSSR AN:"Glass Instead of Metal" under the heading: "Science at work in production"]

[Text] /The republic's 6th scientific and technical conference on composite materials based on polymers is beginning in Gomel on November 27th. The place for holding the conference was not selected by chance. It is here that the personnel of the Institute of the Mechanics of Metal and Polymer Systems of the BSSR AN work effectively at coordinating the basic and applied research being done in the republic in the field of the development and use of new composite materials based on polymers.

In the years of the 11th Five-Year Plan alone, institute personnel have introduced 68 developments at 84 enterprises for an economic gain of 23.8 million rubles./ [Paragraphs enclosed in slant lines in boldface]

Raw materials and materials. From year to year their mining and finishing costs more. For instance, in the industry of our republic almost 60 percent of the cost of products is for materials. Moreover, the traditional materials all the more frequently do not satisfy present day demands placed on new equipment for strength and wear resistance, and stability under the influence of high and low temperatures, various kinds of radiation, and aggressive liquid or gaseous environments. All this stimulates an active search for new structural materials, primarily composites, in which there is an optimal combination of the positive properties both of the principal natural materials and the artificially prepared ones.

Here are some examples of the realization of the program goals. At enterprises metal pipes usually are used for the transport of aggressive liquids. Although they are made from stainless steels and nonferrous metals, they are shortlived and costly. At the same time, glass resists chemical actions well, but pipes made from it are not strong and are difficult to connect. At the institute a new technology and special equipment were developed for covering glass pipes and their connecting elements with polymer coatings which fulfill reinforcing, protecting, and insulating functions. One kilometer of

glass polymer piping replaces 12-15 tons of ferrous or 4-5 tons of nonferrous metal for a saving of up to 15,000 rubles. The production of such pipe has begun and is being expanded at the Gomel Glass Plant imeni M.V. Lomonosov.

We also have been successful in improving the pipes used in the construction of irrigation systems. The thing is, that the polymer coating can be porous. The corrugated irrigation pipes coated with it are resistant to sedimentation and salinization. New polymer drainage systems are being tested successfully in Belorussia and in Stavropol, the Ukraine and the Far East.

The principles which have been developed for making composites have permitted obtaining new high-strength structural materials. Thus, the service life of bearings made of such materials is being increased more than twofold because of the introduction into the polymers of small quantities of multifunction additives with lubricating, antioxidant, and structural properties. Self-lubricating materials, called SAM, are being used in the friction assemblies of automobiles and agricultural machinery which increases their service life. In the Pinsk Textile and Tricot-wear Production Association a section already is working on the production of parts made from such materials to provide for the needs of this branch of industry.

The technology developed at the institute for making materials and articles from polymer antifriction composites is arousing great interest among machinery and instrument makers. For example, an anticorrosive film for the automated preservation and packaging of metal articles is extremely effective.

From the results of research and development done at the institute in the 11th Five-Year Plan, nine shops or sections will have been newly built or modernized. In addition to what has been mentioned, there is the production of insulating jackets for agricultural buildings from the by-products of the production of the Zhlobinsk Artificial Fur Factory, there are the sections for the manufacture of pipes, planks, and shapes with widespread usefulness made from the by-products of wood in Soligorsk and Vetka, there is the production line for waterproofing and chemical- resistant materials in Vitebsk, there is the shop for the manufacture of polymer parts for feed harvesting equipment at the PO [Production Association] Gomsel'mash, and so on.
We are also conducting joint work with such large production associations as the Minsk Tractor Plant and BelavtoMAZ [expansion unknown].

Participating in the realization of important scientific and technical programs, we always see the distinct deficiencies of their formation and implementation.This includes weak participation of the industrial sciences. It is necessary to so construct the cooperation of the partners that quick delivery will be made of specific program assignments from the academic establishments to the industries and further, into production. It is advisable in our opinion, also to activate the role of the standardizing bodies in the development of the technical specifications and the regulations for testing and accepting experimental or industrial models of new equipment and technology.

Material supply for experimental work remains a tight situation. Scientists occasionally lose months or years in the search for needed setups and then they accept variants which are not at all optimal - knowingly degrading the parameters of the equipment or technology being developed. And actually, it was worth it for the Republic Interdepartmental Commission on the Saving and efficient Use of Material Resources to consider the developments of our institute last year and give appropriate commissions to the supplying bodies, as the situation has notably improved. If in the annual plans the Gosplan [The State Planning Commission] and the Gossnab [State Committee for Material and Technical Supply] of the republic would consider line by line the supplies for the performers of the scientific and technical programs independent of their departmental affiliation, the realization of valuable developments would be accelerated.

For our industry the sciences are the great and interesting future. If we now live, as it is customary to consider it, in an era of composite materials, then no less true is the claim that already today the scientific foundations are being laid for the creation of the materials of the future age which, descriptively are called "intellectual composites". These will be materials which, depending on external factors , are capable of guiding a change in their properties, approximating the functional capabilities of living organisms.

The first efforts to create such materials and structures already have been made in our institute. In particular, the use of liquid crystal and magnitosensitive systems as functional additives to hard and liquid composite materials permits effective control of their properties. The formation on granules of mineral fertilizers of polymer films with ionic conduction makes it possible to regulate the supply of the feeding substances to the plants depending on the moisture in the surroundings. The application in composites of polymer components endowed with the "effect of deformation memory" permits developing actuating mechanisms which are self-adjusting in distance.

The future is for composite materials. To bring it nearer, developing the science of polymer materials and increasing their contribution to scientific and technical progress - in this, the personnel of the Institute of the Mechanics of Metal and Polymer Systems of the BSSR AN see their duty.

CSO: 1842/59
9136

UDC 539.4

LOCAL ELASTOPLASTIC FRACTURE OF FIBROUS COMPOSITE MATERIALS

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 20, No 5, Sep-Oct 84 (manuscript received 22 Apr 83) pp 57-64

BEREZHNITSKIY, L. T. and KUNDRAT, N. M., Physico-Mechanical Institute imeni G. V. Karpenko, UkSSR Academy of Sciences, L'vov

[Abstract] A mathematical model of fiber-reinforced composite materials is constructed for analysis of their local elastoplastic fracture, assuming the fibers to be perfectly rigid but of finite strength. The corresponding plane problem is formulated in a Cartesian system of coordinates and is solved for an infinitely large isotropic plate containing two collinear fibers of equal length. The material of the binder and the contact layers is assumed to be ideally elastoplastic and uniformly strong, satisfying the Trask-St. Venant condition. The plate is under uniaxial tension in the direction of the fibers. The solution to the equations according to the theory of elasticity yields the dependence of the lengths of slip bands on the applied force, on strength and elastic properties of the composite, and on interaction of the fibers. The limiting case of a very narrow gap between the fibers corresponds to the condition of fiber rupture. The results indicate that the critical fiber length increases and the critical load decreases for a binder material with lower shear modulus, a contact layer with lower shear strength, and smaller maximum allowable displacement discontinuities. For a binder material with smaller Poisson ratio the critical fiber length also increases, but the critical peeling load increases as well. Figures 5; references 15: 13 Russian, 2 Western (1 in Russian translation).
[48-2415]

ENERGY EFFECTS

UDC 537.311:621.382

INFLUENCE OF LASER RADIATION ON STRUCTURE AND MICROHARDNESS OF CADMIUM MONOANTIMONIDE

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 20, No 6, Nov-Dec 84 (manuscript received 24 May 83) pp 100-101

GOTRA, Z. Yu., BOBITSKIY, Ya. V., KOTUR, B. Ya. and POKHMURSKAYA, A. V., L'vov Polytechnical Institute imeni Lenin's Komsomol

[Abstract] A study is made of the influence of laser radiation on the structure and microhardness of single crystals of cadmium antimonide. The initial material used consisted of cadmium antimonide single crystals grown by zone recrystallization with a carrier concentration of 10^{16}-10^{17} cm^{-3}. It was found that laser irradiation did not lead to structural phase transformations. The data agree with results of measurement of microhardness which may increase by up to 30% in the irradiated zone. There is a certain energy interval in which microhardness significantly increases (up to about 0.1 $MJ \cdot m^{-2}$) for the materials studied. It corresponds to the energy of formation and accumulation of defects. At higher energies of irradiation, local melting of the material and its crystallization occur. The microhardness of such zones is practically independent of irradiation energy within the range mentioned. Figures 1; references: 3 Russian.
[86-6508]

UDC 621.9.048.7

DYNAMICS OF THERMAL RUPTURE OF COMPOSITE MATERIALS UNDER THE INFLUENCE OF OPTICAL RADIATION

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian, No 6, Nov-Dec 84 (manuscript received 16 May 83) pp 21-23

GAVRIKOV, V. K. and KOVTUN, I. I., Khar'kov

[Abstract] A special laboratory installation was used to study the dynamics of thermal rupture and temperature of composite material specimens ruptured by continuous CO_2 laser radiation. Six independent lasers in a cylindrical

pattern were used, each laser having a radiated power of 45-50 W. Flat metal mirrors and a hexagonal pyramid and lens were used to focus the radiation on a common spot on the specimen which was in a vacuum chamber. Specimens of hetinax, ebonite and glass-reinforced textolite were observed by a high-speed motion picture camera. Rupture kinetics were found to depend essentially on the presence or absence of a film of the melted material, which acted to protect the undamaged sections of the material and decrease the fraction of energy absorbed by the specimen due to its higher coefficient of reflection. The brightness temperature of the specimens was found to fluctuate broadly as a function of material type. Figures 3.
[51-6508]

UDC 621.791.72(04)

EFFECTIVE EFFICIENCY OF ELECTRON BEAM HEATING OF METALS.

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 4, Jul-Aug 84 (manuscript received 31 Mar 82) pp 31-34

LYUBIN, M. I., ZVYAGIN, V. B., SELISHCHEV, S. V. and ZUYEV, I. V., Moscow

[Abstract] The energy balance of a primary electron beam is calculated considering its distribution through the length of the evaporation channel and reflection of primary electrons from the walls of the channel in an electron beam metal heating installation. The interaction of electrons in the primary beam with the vapor, melt and slow electrons is ignored, as is the interaction of primary electrons among themselves. The efficiency of electron beam heating of the bottom of the welding bath as a function of evaporation channel length is found to have a maximum at a certain value of beam convergence angle at the product and for focusing of the beam on the surface of the metal. As the depth of the channel increases the distribution of specific energy through the cross section of the channel is gradually smoothed and becomes uniform. Geometric focusing of primary beam electrons by the walls of the evaporation channel is observed. Figures 4; references 4: 2 Russian, 2 Western.
[002-6508]

UDC 539.04

SPECIFICS OF LASER HEATING OF METAL IN AN OXIDIZING ATMOSPHERE

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 277, No 6, Aug 84
(manuscript received 26 Aug 83) pp 1395-1399

RYKALIN, N. N., Academician, UGLOV, A. A., SMUROV, I. Yu. and VOLKOV, A. A.,
Institute of Metallurgy imeni A. A. Baykov, USSR Academy of Sciences, Moscow

[Abstract] A study is made of the nonlinear nonsteady three-dimensional problem of heating a semi-infinite body by CO_2 laser radiation, considering the growth of the oxide film and the resultant change in absorptive capacity. The flux density of the incident radiation is assumed to be great, at lease $10^5 — 10^6$ W/cm^2, so that heat losses from the surface can be ignored. The analytic solution of the problem obtained allows qualitative description of all characteristic metal heating modes in an oxidizing atmosphere previously observed experimentally. Figures 4; references 10: 9 Russian, 1 Western. [012-6508]

UDC 539.9.12

SURFACE HARDENING OF STEELS BY EXPOSURE TO INTENSIVE PULSED ELECTRON BEAM

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian, No 6, Nov-Dec 84
(manuscript received 25 May 82) pp 119-122

ITIN, V. I., KOVAL', N. N., MESYATS, G. A., ROTSHTEYN, V. P. and
CHUKHLANTSEVA, I. S., Tomsk

[Abstract] A study is made of the possibility of using electron beams with $q \simeq 10^5$ W/cm^2, $eU \simeq 20$ KeV, pulse length about 10^{-4} s for surface heat treatment. Surface hardening and changes in the structure of steels with varying content of carbon under the influence of the pulsed electron beam were investigated. Specimens treated were in both annealed and hardened states, and consisted of plates 20 x 40 x 6 mm. The beams were found to cause an increase in microhardness by a factor of more than 3 in comparison to annealed specimens, 20% in comparison to hardened specimens. Two layers of elevated hardness arise as a result of cooling from high temperature. The thermal stresses lead to an increase in hardness in comparison to ordinary hardening. The method has a number of advantages over laser treatment: beams with large cross sections can be achieved, beam control is easy and high efficiency installations can be produced. Figures 4; references: 6 Russian.

GLASS AND CERAMICS

UDC 666.76+01+620.174+621.48

STRENGTH AND CRACK RESISTANCE OF CERAMICS, REPORT 1. CORDIERITE

Kiev PROBLEMY PROCHNOSTI in Russian No 12, Dec 84 (manuscript received 21 Nov 83) pp 7-11

GOGOTSI, G. A., ZAVADA, V. P. and KHARITONOV, F. Ya., Institute of Problems of Strength, UkSSR Academy of Sciences, Kiev

[Abstract] Use of ceramics in machine building requires development and perfection of methods for mechanical testing to define precise characteristics in the operating temperature range. The present article presents results on study of cordierite and reaction-annealed silicon nitride, formed and cut into prisms with rounded edges. Durability limits were calculated on the basis of maximum load without considering nonlinear deformation. Samples were subjected to double torsion in an oven with a platinum-rhodium cover. Further tests of cordierite ceramic were made on slabs 5 x 100 x 300 mm in size made by semi-dry pressing from 0.3-0.8 mm granules at 50 MPa. Previous findings on the nonlinear nature of cordierite's deformation were tested in a temperature range of 20-1000°C. Clear temperature dependencies were noted: at 600°C, reduced durability was accompanied by decreased deformation, with increased brittleness and deflection angle tangent, while at 1000°C resilience increased along with improved crack resistance and a lesser deflection angle tangent. Further study of the ceramic's behavior at 600°C is recommended. Figures 4; references 9: 6 Russian, 3 Western.
[65-12131]

UDC 666.76.01+620.174+621.48

STRENGTH AND CRACK RESISTANCE OF CERAMICS. REPORT 2. SILICON NITRIDE CERAMIC

Kiev PROBLEMY PROCHNOSTI in Russian No 12, Dec 84 (manuscript received 21 Nov 83) pp 11-15

GOGOTSI, G. A., ZAVADA, V. P. and SHCHERBINA, O. D., Institute of Problems of Strength, UkSSR Academy of Sciences, Kiev

[Abstract] The present article presents results of study of physicomechanical characteristics of silicon nitride ceramic which is used for gas turbine and internal combustion engine parts. Thermal and mechanical tests were made on strips 3.5 x 5 x 50 mm and 3.5 x 90 mm, and slabs 3 x 25 x 75 mm in size. Results indicated a temperature dependence of mechanical properties with the pressed ceramic behaving like reaction-annealed counterpart products at 20°C. While the latter retained its properties at up to 1500°C, the test ceramic retained its strength only to 1000°C, then began to lose strength until at 1400°C it had been reduced by half. Further study was made to determine static and dynamic characteristics such as crack spread at levels below critical failure. Lateral bending tests were also made. Results coincided with calculated projections of severe loss of durability at 1400°C. The use of precritical crack development methods for determining the useful life of ceramics under high-temperature conditions was considered confirmed. Figures 5; references 7: 4 Russian, 3 Western.
[65-12131]

UDC 620.179

STUDY OF PIEZOPROPERTIES OF FERROELECTRIC CERAMICS

Kiev PROBLEMY PROCHNOSTI in Russian No 12, Dec 84 (manuscript received 12 Apr 83) pp 15-17

KUZ'MENKO, V. A., NISHCHENETS, V. N., PISARENKO, G. G. and KHAUSTOV, V. K., Institute of Problems of Strength, UkSSR Academy of Sciences, Kiev

[Abstract] Current use of piezoceramics includes hydroacoustic irradiation, wherein the accumulation of microscopic flaws in the material becomes an important factor. The present article reports on development at the Institute of an optical device for precision measurement of piezoproperties of ferroelectric ceramics. A helium-neon laser was used to study "TsTBS-3" piezoceramic samples 100 x 10 x 3 mm in size to determine the piezoconstant $\underline{h}_{31}$. Results indicated that 63% of the test samples had $\underline{h}_{31}$ values of about -10×10^8 V/m. These data coincide with those obtained with this piezoceramic using other methods. The laser interferometer has a 30 Å resolution capability and an accuracy of 0.05% error for quasistatic deformation. Cyclic loads

of 20 KHz and 60-second duration were found to cause 8-48% expansion of the material in an amplitude range of 27-47 MPa. Figures 2; references: 7 Russian.
[65-12131]

UDC 666.263.2:620.174

DEFECT CONTENT AND STRENGTH OF SITALLS

Kiev PROBLEMY PROCHNOSTI in Russian No 7, Jul 84 (manuscript received 17 Aug 82) pp 79-84

DUBOVIC, V. N. and RAYKHEL', A. M., Konstantinovka, "Avtosteklo" Plant

[Abstract] A study is presented of the level of strength of three sitalls (glass ceramics) of various systems as a function of their defect content. A luminescent penetrating fluid was used as an indicator, revealing surface defects less than 1 μm in diameter. The combined defect content of the specimens was calculated, including both surface defects and polycrystalline structure defects within the body of the specimen. The studies established that AS-418 and STL-10 sitalls contain both types of defects, with cracks resulting from working penetrating to a depth of 200 μm. Etching of the surfaces of KD sitalls with acid solutions decreases the dimensions and surface density of working defects, to the point of eliminating them completely to this step. Methods of linear fracture mechanics are used to estimate the strength of sitalls corresponding to standard defect levels. It is shown that combined defect sitalls have three strength levels corresponding to surface working and structural defects and defects at the interface boundaries of the polycrystalline structure. Homogeneously defective sitalls have two strength levels, determined by structural defects and interphase defects. Figures 2; references: 9 Russian.
[146-6508]

POWDER METALLURGY PRODUCTION PROBLEMS

Moscow IZVESTIYA in Russian 15 Jan 85 p 2

[Article by S. Kiparisov, rector of the Moscow Institute of Fine Chemical Technology imeni M. V. Lomonosov, appears under the rubric: "Agenda of Ministries and Departments--Roadblocks for Powders"]

[Text] Powder metallurgy holds a special place among the various metal processing methods. These methods enable the manufacture of many types of products (for example, automobile parts) and a significant saving of metal and manpower. Powder metallurgy provides the national economy with materials, without which scientific-technical progress would be inconceivable.

In recent years, much has been done to develop an experimental base, and to organize the manufacturing of different powders and products made from them. However, these may be considered as only the first steps. The production of iron powders, which are the basis of the new direction in metallurgy, so far is 38 percent lower than the target figure, and the production of copper based powders is 44 percent lower. Consequently, the output of products made from these materials is substantially behind the planned quotas. One of the reasons for this is the intolerably slow building up of capacities. For instance, at the Sulinskiy Metallurgical Plant of the USSR Ministry of Ferrous Metallurgy, the implementation of new outputs in this five-year plan is only one fifth of the planned figure due to builders being behind in their work. In the next few years, all measures should be taken to eliminate this lag.

The quality question of the produced powders is still acute. The output of the highest grades of this production, needed for the manufacture of products of complex configuration and precise measurements, is far from adequate to meet the growing needs of the national economy.

Also, the existing prices for powders do not satisfy industry. For instance, the PZh2 type powder is produced in small quantities mostly at the Sulinskiy Metallurgical Plant and is sold at an extremely high price, established by agreement between the Ministry

of Ferrous Metallurgy and Ministry of the Automobile Industry. Of course, this hinders powder metallurgy development.

After the production of this powder goes to the planned capacity, which is planned for 1986, the production cost will be reduced. In our opinion, even now the plant has the potential to increase output and reduce production cost, Specifically, this may be done by replacing the inefficient furnace with a new one, designed at the Institute of Gas, UkSSR Academy of Sciences. This alone will increase powder output by a factor of 1.5. There are also real ways of substantially reducing the cost.

One has to face the fact that until now we have had no strict scientific basis for the fields of application of the various powder types, differing not only in price, but in their qualities.

Alloy steel powders are produced by the Ministry of Ferrous Metallurgy in the form of experimental batches and at very high prices, and this restrains their use. The problem of expanded production may be solved by using the chips--the scrap from machine building production. However, so far this potentiality has not been used satisfactorily. Implementation of a corresponding goal of the USSR GKNT [State Committee of the USSR Council of Ministers on Science and Technology] program has been upset: the All Union Scientific Research Institute of the State Trust for the Procurement and Processing of Secondary Ferrous Metals (city of Lipetsk) as yet has not started the work entrusted to it.

Products from iron based powders are manufactured at more than one hundred enterprises of the different ministries and departments. The same types of products, manufactured under different production conditions, differ significantly from each other in their properties. Moreover, the present high cost of powders and instruments for the formation of intermediate products makes it clear that only large scale production of products is economically profitable with this method. Small productions will never be profitable.

An important reserve for improving the efficiency of powder metallurgy can be the reduction of waste for raw materials and basic supplies that ranges from five to fifty percent in the different departments. In many cases, the products made from powders are intermediate products which require further processing. The reason for this is that the press equipment is not sufficiently accurate. The question has already been raised in the press about the Pinsk Plant of Forge-Press Transfer Lines and the Chimkent Production Association for Forge-Press Equipment Output; these organizations have been supplying equipment to a manufacturing plant, under construction in the city of Molodechno, that is useless for manufacturing metal powder products.

The problem of introducing powder coatings needs to be solved as well. Here, the difficulties are that there is a shortage of powders, and those that are available are used only at the enterprises of three branches--State Committee of Agricultural Technology, Ministry of Motor Transport, and Ministry of the River Fleet. Powder coatings are certainly needed; however, if the coatings can be deposited in the course of basic production at the enterprises of the machine building ministries, the effect will be incomparably greater.

Extensive implementation of powder metallurgy in the national economy is being restrained, as well as problems of organization. These matters are particularly acute at enterprises of the Russian Federation. On one hand, the need for powder parts of mass use has already been calculated. On the other hand, most of the industrial ministries producing powder products do not have the available personnel or capacities that are essential for this. We think the solution is to establish regional scientific-production associations. Scientific supervision of these associations could be carried out by the leading higher education institutions, in which highly qualified specialists work. The decision to establish a branch laboratory with a base for semi-industrial tests in Tomsk is gratifying. A number of RSFSR ministries will participate in establishing this laboratory.

At this time, the coordination of efforts of many departments in this field of production is being carried out by the scientific council on powder metallurgy and composition materials of the USSR GKNT. However, its efforts are already inadequate considering the scope of powder metallurgy in our country.

We think that in the near future the establishment of union nongovernmental organizations of powder metallurgy (with the USSR Council of Ministers or USSR State Plan), based on the Belorussian Council of Ministers of the same designation, is advisable. This will enable the persual of a single scientific-technical policy in this field, and the improvement of the technico-economic indicators of powder products on a national scale.

12525
CSO: 1842/72

UDC 621.762:533.92

USE OF LOW-TEMPERATURE PLASMA FOR PRODUCING ULTRADISPERSED COPPER POWDERS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 84 (manuscript received 31 Oct 83) pp 23-28

KURKIN, Ye. N., TROITSKIY, V. N., TORBOV, V. I. and GUROV, S. V., Institute for New Chemical Problems, USSR Academy of Sciences

[Abstract] Development of new composition materials, especially for electronic and electrical uses, requires production of copper powder with high purity and dispersion, which cannot be accomplished with traditional methods such as hydrogen reduction or chemical precipitation. The present article reports data on the granular composition of copper powders produced in a low-temperature plasma current and based on hydrogen reduction of copper chloride: $2CuCl + H = 2Cu + 2HCl$. The plasmochemical process, conducted at 500-1000°K with nearly 100% yield, required more than 10 times stoichiometric quantities of hydrogen. Plasma generation using argon gas involved 8 KWT of electrical energy. The devices and procedures used are described. All copper particles produced were spherical in form and generally were formed into chains. A coalescent reaction process was central to the process, although calculations had earlier indicated that such a process was impossible. The copper particles had diameters of less than 0.1 micron, and about 0.1% oxygen content by weight. Copper chloride consumption affected particle dimensions, but gas consumption did not. Figures 4; references 8: 5 Russian, 3 Western. [62-12131]

UDC 621.762.04

PRODUCING POWDER MATERIALS FROM TITANIUM BY HOT STAMPING METHOD

Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 84 (manuscript received 25 Nov 83) pp 39-44

LYASHENKO, A. P., PAVLOV, V. A., BOGUSLAYEV, V. A., KARLOV, L. A. and AVRUNINA, G. V., Zaporozh'ye Machine-Building Institute

[Abstract] Quality control of products made by hot stamping of titanium powders depends on even distribution and homogeneity of the fine granular structure. The present article reports on management of consolidation and structure by a gas saturation process of PTES-1 titanium annealed in a vacuum of $2.66 \cdot 10^{-2}$ at 1200°C for 3 hours. Heating during stamping was to 850, 950 and 1000°C in a resistance furnace. Analysis showed that microhardness declined from the surface toward the center of test objects, with 3 clear zones identified. Use of argon as a protective gas helped to reduce the depth of gas saturation. Duration of heating was also significant, with the optimum period

judged to be that between initial loading and balance between the first and second thermocouple. Oscillograms of hot-stamped powder and regular forged metals had the same progression of pressure changes, which were related to their density. Stages in pressure progression are discussed, and optimum heating and densification procedures recommended, so that oxygen content by weight after heating in argon to 850-950°C and hot stamping will not exceed 0.18%; with heating to 1000°C, oxygen content increased to 0.36-0.42%. Figures 5; references: 2 Russian.
[62-12131]

UDC 669.3:532.64:549.21

WETTING OF NATURAL GRAPHITE WITH COPPER ALLOYS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 84 (manuscript received 28 Nov 83) pp 60-62

KISHKOPAROV, N. V., CHENTSOV, V. P., FRISHBERG, I. V. and PASTUKHOV, V. P., Metallurgical Institute, Urals Scientific Center, USSR Academy of Sciences

[Abstract] Electrical contacts currently are made of mixed powders of copper, zinc, lead and natural graphite, but future contacts may be of chemically or thermally metallized graphite. The present article reports on wetting of natural graphite with a droplet in a temperature range of 1523-1823°K in helium to obtain the desired low electrical resistance and pressure similar to that of copper during saturation. Metals tested included copper and its alloys with iron, cobalt, nickel, aluminum, zinc and combinations. The substrate was 20 mm in diameter, of natural graphite pressed at $2 \cdot 10$ N/m^2 pressure and 1773°K temperature for 1 hour. Results showed that 10% concentrations of iron and cobalt in the copper began to wet the graphite, while aluminum did so at above 3%; the other metals showed lesser activity. Cobalt and nickel wetted the natural graphite better than previously tested additives to copper. Figures 2; references 4: 3 Russian, 1 Western.
[62-12131]

UDC 669.762

METHODS FOR OBTAINING ALUMINUM POWDERS AND AREAS OF THEIR APPLICATION

Kiev POROSHKOVAYA METALLURGIYA in Russian No 12, Dec 84 (manuscript received 21 Oct 83) pp 32-37

GOPIYENKO, V. G., KISELEV, V. P. and ZOBNINA, N. S., All-Union Scientific Research and Planning Institute for Aluminum, Magnesium and Electrode Production

[Abstract] This article summarizes methods and products in aluminum powder metallurgy, and mentions several applications of these processes. Forms of the initial product include powders, a pulverized form, scale-shaped particles with linear dimensions exceeding thickness by 50-200 times which commonly are coated with surface-active substances and 25-35% liquid, and granules of various shapes with 0.5-1.0 mm diameter. Physicomechanical processes such as compressed gas atomization, centrifugal and mechanical pulverization, and physicochemical processes including thermal reduction, vaporization-condensation, and electrolytic processes are discussed. The authors suggest that powder metallurgy is widely used for military production in the United States, but for civilian uses in Japan. Applications in ferrous metallurgy and chemical production are outlined. These include corrosion prevention and as a dressing in thermal processes for steel. Aluminum powders are also used in combination with the refractory metals. Some 5,000 tons were used in the USA for more than 100 types of products. Types and applications of aluminum powders in the Soviet Union are presented in tabular form. Soviet applications include electronics, machine and tool making and construction. Low-grade and by-product aluminum is used for some of these applications. References: 3 Russian.
[54-12131]

UDC 532.526.7

HIGH-TEMPERATURE FRICTION AND SOME PROPERTIES OF HOT-PRESSED BORON CARBIDE

Kiev POROSHKOVAYA METALLURGIYA in Russian No 12, Dec 84 (manuscript received 10 Jan 84) pp 41-43

TKACHENKO, Yu. G., YURCHENKO, D. Z., YULYUGIN, V. K., MOLYAR, V. N., MURZIN, L. M. and LUGOVSKAYA, Ye. S., Institute of Problems of Materials Science, UkSSR Academy of Sciences

[Abstract] Previous studies have shown that boron carbide has high wear resistance under various dry friction conditions, including at high temperatures in a vacuum. The present article reports on temperature dependency of the friction coefficient and wear rate with frontal friction of a B_4C-B_4C pair

in conditions of heating to 1673°K in a vacuum of approximately 1 Pa and to 1273°K in normal air. Results showed that in the temperature range of 300-1100°K, friction and wear both gradually increased, but with further heating to 1700°K, both declined. In the atmospheric test, the minimum wear rate was noted at 900-1000°K. Metallographic tests showed the boron carbide to be covered with fine oxide spots of ~ 20 GPa microhardness at 800-900°K in air. At 100°K, a continuous boron hydroxide film appeared. Electrical resistance was negative throughout the tests, and showed rapid changes in the temperature range of 450-600°K. Above 600°K the test material showed plasticity, while at 300-600°K brittle failure accounted for considerable wear. The boron carbide was judged to be a useful product under friction in a wide temperature range in both vacuum and atmospheric pressure conditions. Figures 3; references 11: 9 Russian, 2 Western.
[54-12131]

UDC 621.793:669.018.45

EFFECT OF PHASE-STRUCTURE STATE AND APPLICATION CONDITIONS ON DURABILITY OF DETONATION COATINGS OF VK-TYPE ALLOYS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 12, Dec 84 (manuscript received 5 Aug 83) pp 50-55

IVASHCHENKO, R. K., KADYROV, V. Kh., MIL'MAN, Yu. V., FEDORENKO, V. K. and KHAYRUTDINOV, A. M., Institute of Problems of Materials Science, UkSSR Academy of Science

[Abstract] Durable detonation coatings of the VK-type have wide application for prolonging jet engine blades. The present article reports on a study of reduced temperatures and accelerated particles during detonation, with WC particles of 20-40 mkm as factors in obtaining coatings like those produced by regular powder metallurgical procedures. Phase, structure, bond with the substrate metal, durability during torsion, and low-temperature behavior of such coatings were compared to VT3-1 titanium alloy and "steel 3" with and without coatings. The role of gases, atomization conditions and rate of cooling in the final product are discussed. Results showed that precise composition had little impact on durability during torsion, since considerable structural and phase cariations were found in any case and high internal tension was a feature of the coatings. Granular and chemical features were, however, found to be very important in determining durability. Durability and plasticity were found to decline as coatings increased in thickness. Figures 4; references: 11 Russian.
[54-12131]

UDC 621.762:669-153:621.785.3:539.377

EFFECT OF ANNEALING ON STRUCTURE AND TEMPERATURE DEPENDENCE OF MICROHARDNESS OF AMORPHOUS METALLIC ALLOYS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 12, Dec 84 (manuscript received 23 Aug 84) pp 69-75

MIL'MAN, Yu. V., OVCHAROV, V. P., PAN, S. V. and RACHEK, A. P., Institute of Problems of Materials Science, UkSSR Academy of Sciences

[Abstract] Recently amorphous metallic alloys produced by powder and spinning metallurgical procedures have bound wide application. Little study has been made, however, of the effects of temperatures below room temperature. The present article reports on microhardness of a number of amorphous metallic alloys (AMA) of metal-metalloid types based on Fe, Co and Fe-Ni at 77-293°K, as well as the effects of annealing at 473, 673 and 873°K for 0.5 hours in an argon medium. Results showed that isothermal annealing below crystallization temperature had little effect on structure or microhardness. While microhardness showed little dependency on temperature in the range of 200-300°K, as temperature decreased from 200 to 77°K microhardness increased markedly. After preliminary annealing in which the test alloys were not crystallized, little temperature effect on microhardness was noted. Conventional yield point varied little and remained within a 3.0-4.4 range. Figures 5; references 14: 8 Russian, 6 Western.
[54-12131]

UDC 539.374

EFFECT OF STRUCTURE AND MATRIX PROPERTIES ON CRACK RESISTANCE OF HARD ALLOYS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 12, Dec 84 (manuscript received 18 Nov 83) pp 78-81

NOVIKOV, N. V., DEVIN, L. N., MITLIKIN, M. D. and UL'YANENKO, A. P., Institute of Superhard Materials, UkSSR Academy of Sciences

[Abstract] Not only quantity but size and nature of carbide granules and cobalt binders are known to affect mechanical properties of hard alloys. The present article reports on results of automated analysis of tungsten-cobalt hard alloy structure with 6-25% by weight binder. Optical and photographic methods were used to reveal alloy structures. Results showed that 60-85% of granules were 0.1-2 mkm. Viscosity was lower for WC6, WC10 and WC25 than for WC15, and tempering promoted an increase in matrix viscosity, thus improving the alloy's mechanical properties. Precise determination of structural parameters made it possible to establish viscosity extremes for various WC alloys and to improve their crack resistance. Figures 1; references 7: 5 Russian, 2 Western.
[54-12131]

UDC 621.762.04

EFFECT OF DEGREE OF DEFORMATION AND STAMPING TEMPERATURE ON STRUCTURE AND PROPERTIES OF POWDERED TITANIUM ARTICLES

Kiev POROSHKOVAYA METALLURGIYA in Russian No 12, Dec 84 (manuscript received 8 Dec 83) pp 90-93

PAVLOV, V. A., LYASHENKO, A. P., BOGUSLAYEV, V. A. and AVRUNINA, G. V., Zaporozh'ye Machine-Building Institute

[Abstract] Hot stamping of porous powder-metallic articles makes is possible to produce items with minimum porosity and mechanical properties close to those using forge technology. The present article reports on the effects of temperature and deformation on producing articles in a transverse direction. The tests were made on electrolytically produced PTES-1 and PTEK-1 powders and a titanium alloy. After hot stamping and annealing, density and mechanical properties such as fracture and blow resistance were determined. Results showed that articles with 99% density and more could be produced by hot stamping with deformation below 20 and above 50%, but for the first, rather long pressure treatment was required, while the second needed 15-20% higher pressure to eliminate fissures. The metal produced with PTES-1 powder had large polyhedrical granules, while that using the titanium alloy had platelet-type granules. Relative density was like that of stamped articles with 10-60% deformation. Mechanical properties depended on the temperature of stamping, with greatest density and plasticity at 850-950°C. Gas saturation was another factor in determining density. Figures 3; references: 5 Russian.
[54-12131]

SERGEY SERGEYEVICH KIPARISOV, ON HIS 60th BIRTHDAY

Kiev POROSHKOVAYA METALLURGIYA in Russian No 12, Dec 84 p 94

[Abstract] This note in honor of S. S. Kiparasov's 60th birthday traces his career from school in Saratov, military service, and education at the Moscow Institute of Nonferrous Metals imeni M. I. Kalinin, to his leadership of the Moscow Institute of Fine Chemical Technology. Party and paraprofessional activities include service in various councils for the study of powder metallurgy, editorial work, and low-level political posts. His professional interests include broad topics in powder metallurgy and refractory metals. He has published monographs, textbooks and numerous articles, and has been awarded the Order of Labor's Red Banner.
[54-12131]

STEELS

UDC 669.14.018.298:620.178.4

EFFECT OF WALL THICKNESS OF GAS PIPELINE MADE OF THERMALLY PROCESSED STEEL ON FAILURE RESISTANCE

Moscow METALLOVEDENIE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 12, Dec 84 pp 15-17

AL"TZITSER, M. Ya. and BOLOTOV, A. S., All-Union Scientific Research Institute for Construction of Major Pipelines

[Abstract] Wall thickness of tubing determines metal's resistance to brittle and extension failure, and is controlled by the temperature of brittleness and by flow resistance. The present article presents results of studies of standardized and thermally enhanced pipe treated at half the temperature of brittleness, and subjected to impacts of various magnituces. The steel tested, 14G2FB with 0.14% C, 1.45% Mn, 0.37% Si, 0.020% S, 0.020% P, 0.06% V, 0.04% Nb, 0.10% Cu, 0.06% Ni and 0.1% Cr, was tempered by immersion in water to drop temperature from 910°C to 650°C; other samples were not tempered. The resulting tempered steel had a finely dispersed ferrite-carbide mixture with 10-15% polygonal ferrite, while the untreated steel contained 60% ferrite. Strength tests then showed that the tempered steel became brittle at a significantly lower temperature than the untreated samples. The resistance to brittle failure relative to wall thickness showed a nonlinear dependence, while blow resistance was in linear dependence on wall thickness. Figures 2; references: 5 Russian.
[63-12131]

UDC 620.193.629.12

INITIATION AND GROWTH OF LOW-FREQUENCY FATIGUE CRACKS IN 15KhN5DMF STEEL IN SEA WATER

Kiev FIZIO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 20, No 5, Sep-Oct 84 (manuscript received 16 Mar 83) pp 16-20

MAKSIMOVICH, G. G. and KOBZARUK, A. V., Physico-Mechanical Institute imeni G. V. Karpenko, UkSSR Academy of Sciences, L/vov

[Abstract] An experimental study was made of structural steel 15KhN5DMF in sea water, for the purpose of determining its low-frequency fatigue

characteristics from initiation of a crack through its growth to final fracture. Smooth, flat 2.5 mm-thick strip specimens were tested in pure flexure under a symmetric sinusoidal load at frequencies of 167, 16.7, 1.67 MHz as well as under a symmetric trapezoidal load (3 or 30 s loading time and unloading time) at the 1.67 MHz frequency. In both cases the specimens were loaded up to the yield point (ε = 0.95% strain) and some specimens beyond that level (1.25% and 1.75%). The results reveal that at low-load frequencies cracking and fracture become more intense in sea water than in air. Below and just under the yield point corrosion is dominant and combines with the time factor, a nacre tarnish forming on polished surfaces under a high-frequency load (167 MHz, ε = 0.95%) and pitting as well as corrosion becoming more intense under a low-frequency load (1.67 MHz). As the load amplitude increases, corrosion recedes and the mechanical factor becomes dominant. The resistance to low-frequency fatigue dpends largely on the loading mode, cracks being initiated and fracture occurring sooner under a sinusoidal load than under a trapezoidal one, in either sea water or air. Sea water influences the life of 15KhN5DMF steel parts to a lesser degree before a crack is initiated, but after initiation accelerates its growth. The life is shorter at lower load frequencies, and then shorter in sea water than in air. Increasing the strain rate by an order of magnitude, in any loading mode, lengthens the life by a factor of 1.1-1.4 and, with increasing strain amplitude, the life becomes less dependent on the loading mode and frequency. Figures 4; references: 10 Russian.
[48-2415]

TITANIUM

UDC 539.4

FATIGUE STRENGTH OF ALPHA-TITANIUM ALLOYS UNDER COPHASAL ACTION OF VARIABLE NORMAL AND TANGENTIAL STRESSES

Kiev PROBLEMY PROCHNOSTI in Russian No 12, Dec 84 (manuscript received 8 Mar 83) pp 26-27

SHAMANIN, Yu. A., Arkhangelskaya oblast

[Abstract] Increasing use of titanium and its alloys for highly stressed and varying load applications has emphasized the need for study of fatigue strength of such alloys after periods of use. The present article reports on study of PT-3V, a pseudotitanium alloy with 5 parts aluminum and 2.5 parts vanadium. Test samples 30 mm in diameter were attached to a resonance machine with a revolving vibrator and subjected to bending, twisting and combinations of the two. Results indicated that the tested alpha-titanium alloy underwent fatigue failure as predicted by calculations, but tangential stresses were a better parameter for calculations than normal stresses. Maximum normal stresses, however, were responsible for fatigue cracks. The Gough criterion was found appropriate for evaluating fatigue strength subjected to plane stress factors. Figures 3; references: 5 Western.
[65-12131

UDC 669.3:539.3

STUDY OF STRUCTURAL CHANGES OF DUAL-PHASE TITANIUM ALLOY DURING SHOCK WAVE LOADING

Kiev PROBLEMY PROCHNOSTI in Russian No 12, Dec 84 (manuscript received 18 Mar 83) pp 29-33

PETROV, Yu. N., NADEZHDIN, G. N., SVECHNIKOV, V. L. and ASTANIN, V. V., Institute of Problems of Strength, UkSSR Academy of Sciences, Kiev

[Abstract] Recent research has frequently included study of changes in materials after shock wave loading, which is suggested as a modification of dislocation models of high-speed deformation processes. However, little information on such methods as they relate to titanium and its alloys has been published. The present article reports on study of changes in alpha- and beta-phases of titanium in a dual-phase industrial alloy, VT8. The shock-wave load rates tested were 60 and 600 m/sec. After the procedure, results were assessed by electron microscope. The VT8 alloy had a globular structure, with platelet forms appearing after heating past the alpha→beta transformation point. Results showed that the original structural laminates broke down under the shock wave, with extensive slip and twinning through all alpha-platelets. Twinning was greater at 600 m/sec than at 60 m/sec, with formation of numerous unstable defects on specific alpha-planes of crystals and hydrides in the beta-phase at 600 m/sec. No omega-phase formations were noted after the shock wave loading. Figures 3; references 29: 8 Russian, 21 Western.
[65-12131]

UDC 620.17:669.295:621.78.014

POSSIBLE USE OF RAPID HEATING FOR IMPROVING MECHANICAL PROPERTIES OF TITANIUM ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 12, Dec 84 pp 32-36

YELAGINA, L. A., GORDIYENKO, A. I., BRUN, M. Ya. and IVASHKO, V. V.

[Abstract] Use of rapid heating prior to deformation shaping and in thermal processing of titanium semimanufactured products promises increased production efficiency, but titanium alloys tend to become brittle under such treatment if they show high activity with oxygen, nitrogen or hydrogen. The present article reports on a process to improve heat durability and viscosity of rolled rods with globular granular structure through use of rapid annealing of plate-like granules of less than 300 micron size. A beta-annealing process was used on VT9 and VT18 rods with granules of 5, 50, 100, 200, 500 and 900 micron dimensions. Results showed that with sizes of 50-200 microns,

rapid electric heating to 1050-2000°C brought significant improvement in heat durability. Pulverization of the alloy and subsequent homogenization was preceded by minor alpha+beta deformation. Rapid heating can also be used for pulverization, without deformation. Heating can also be used to promote heterogenity of structure, which resulted in the tests in improved crack resistance and other mechanical advantages in the alloy. Figures 5; references: 6 Russian.
[63-12131]

UDC 620.18:620.17:669.295

EFFECT OF ANNEALING PROCEDURES ON STRUCTURE AND PROPERTIES OF VT6 ALLOY WITH INITIAL LARGE-GRAINED STRUCTURE

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 12, Dec 84 pp 36-39

KRASNOYARTSEVA, L. S., LYASOTSKAYA, V. S. and MOZOLEVSKAYA, O. A., Moscow Institute of Aviation Technology imeni K. E. Tsiolkovsky; All-Union Institute of Light Alloys

[Abstract] Large semimanufactured parts of titanium alloys typically have structure of large granules and reduced mechanical properties, especially plasticity. The present article reports on study of VT6 alloy (with 5.8% Al, 3.8% V, 0.07% Fe, 0.04% Si, 0.02% C, 0.14% O, 0.01% N and 0.002% H) annealed at 1050°C for 2 hours, then cooled. Other samples were annealed at temperatures from 800 to 1050°C for 1 to 5 hours before cooling. With all samples, cooling was either by normal air or gradually to a temperature such as 450°C before regular air cooling. Results showed some decline in granular size after cooling from 800-900°C in air, as the original alpha-phase resolidified after partial melting. At 1000 and 1050°C, thin platelet granules formed with air cooling and thicker ones with oven cooling. Water immersion gave the same results. Plasticity was higher and durability lower for oven-cooled samples. The greatest structural changes were noted after annealing at 900-980°C and air cooling, with formation of thin alpha-phase plates that reduced plasticity. Best plasticity came when alloys were oven-cooled gradually to 450°C before exposure to air. Figures 4; references: 5 Russian.
[63-12131]

UDC 669.295'71:620.178.2

EFFECT OF ALUMINUM ON NATURE OF TITANIUM ALLOY FAILURE

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 12, Dec 84 pp 40-43

POPOV, A. A., and ANISIMOVA, L. I., Urals Order of Labor's Red Banner Polytechnical Institute imeni S. M. Kirov

[Abstract] Use of high-durability titanium alloys is limited by their poor ability to absorb shock after tempering. Failure cracks usually develop in the viscosity system with pitting. The present article reports on study of the effects of chemical composition and thermal processing procedures on the nature of failure of beta- and (alpha+beta) structures in such alloys. Industrial and semi-industrial VT9, VT8, VT3-1, VT22, VT15 and VT30 alloys, which vary in content of Ti, Al, Mo, Zr, Cr, V and Sn, were heated to 1100°C dropping to 800°C for 2 hours, then tempered or air-cooled. Results showed that VT22 and VT15 with beta-structure tempered at above 1000°C had poor energy absorption before failure, with microcracking occurring along granule boundaries. Plastic deformation was less in VT22 than in VT15, of which the former contained more aluminum. Similar patterns were noted in other two-phase alloys. Tempering at a lower temperature resulted in pit transcrystallization as the cause of cracking. The weakest link was between alpha and beta granules, and pit sizes corresponded closely to granule size. Further testing showed that aluminum adsorbed on interphase and intergraule boundaries, thereby weakening them and contributing to cracking of the tested alloys. The distribution of aluminum atoms in a given alloy thus is a crucial factor in determining uses of and subjecting these alloys to thermal processing. Figures 2; references: 7 Russian.
[63-12131]

UDC 669.094.3:669.295

STUDY OF OXIDIZED SURFACE COATING ON TITANIUM AFTER ANNEALING

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 12, Dec 84 pp 43-45

PESHKOV, V. V. and MILYUTIN, V. N., Voronezh Polytechnical Institute

[Abstract] Titanium is generally processed in rarified air due to its tendency to absorb large amounts of oxygen that form oxide coatings on the metal. The present article reports on use of a special ("Raster") electron microscope (REM) to study titanium-oxygen reactions during annealing at various temperatures from 500 to 900°C. Samples of VT1-0 were heated for 1 hour at 0.4-10 Pa pressure, and also annealed under "autovacuum" conditions.

Samples were then cut to 2.5 mm and subjected to a force that caused cracking. Results showed that an oxide coating began forming at 500°C; at 650-700°C the oxide crystals took on globular shape with 0.05 to 0.2 micron diameter at annealing temperatures of 0.4 and 10 Pa, respectively. After autovacuuming the samples had a glittering metallic surface which showed only titanium lines on electronograms. Temperature and air pressure were shown to be factors in both thickness and structure of the oxides formed. With thin oxides (up to 10 microns), cracking took place without formation of facets, while with thicker coatings produced by greater heat, scale facets appeared which, however, decreased in size as oxide thickness increased. The autovacuum procedure prevented oxidation and oxygen saturation. Figures 4; references: 4 Russian.
[63-12131]

UDC 621.77.2.669:295

HOT HYDRODYNAMIC EXTRUSION OF TITANIUM ALLOY BLANKS

Moscow KUZNECHNO-SHTAMPOVOCHNOYE PROIZVODSTVO in Russian No 12, Dec 84 pp 12-14

PETROV, A. P., MASLOVSKIY, P. A., SHIRYAYEV, V. A., NIKOLAYEV, Yu. V. and NARSKOV, G. I.

[Abstract] Extrusion of heat-resistant titanium alloys is difficult due to the very narrow temperature interval of deformation, limited ductility, significant deformation resistance and tendency to adhere to the tool. These shortcomings can be partially eliminated by the use of hot hydrodynamic extrusion in quasifluid media, eliminating direct contact of the metal with the tool. The use of special profiling of the initial blank, with barium chloride melts used as the protecting and lubricating coating, and hardening of the tool surface with titanium nitride has now solved the problem of tool life. Introduction of the technology now developed to industrial production can have a significant economic effect. Figures 2; references: 5 Russian.
[75-6508]

UDC 620.194.8:669.295:669.788

RESISTANCE OF HYDROGENATED α-TITANIUM ALLOYS TO CORROSION-FATIGUE FRACTURE

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 20, No 5, Sep-Oct 84 (manuscript received 26 Aug 83) pp 117-118

SYSHCHIKOV, V. I., SIDOR, P. Ya., BABEY, Yu. I., IVANYUKHINA, G. I. and KLAKIV, M. D., Physico-Mechanical Institute imeni G. V. Karpenko, UkSSR Academy of Sciences, L'vov

[Abstract] The effect of hydrogenation on the corrosion-fatigue resistance of the PT-7M α-titanium alloy and the attendant hydrogen embrittlement were studied experimentally in an aqueous 3% NaCl solution at two low temperatures (273°K, 363°K) and in an aqueous 10% NaCl + 5% $MgCl_2$ solution at a high temperature (513°K). Blank specimens 100 mm long were cut from rods 16 mm in diameter, whereupon 55-60° X-form incisions leaving a neck 1.5-1.6 mm in diameter were at the center of each for subsequent welding with 1.6 mm rods of the same material. After welding, the blanks were degassed and then hydrogenated, some to 0.02% H_2 and others to 0.03-0.035% H_2, whereupon they were machined down to a diameter of 4 mm. Smooth segments, segments with sharp annular notch, and segments with a welding seam were tested for fatigue in pure flexure at the three temperatures, in the corresponding salt baths under a hydrostatic pressure of 3-4 MPa. The results indicate that 3% NaCl has no effect on the 300 MPa fatigue strength of smooth rods at 293°K and 363°K, but that salt lowers it by 10% at 513°K. A sharp annular notch reduces the fatigue strength to 60-70 MPa in salt or in air. The fatigue strength of welding seams increases upon hydrogenation to 0.02% H_2, but further hydrogenation again lowers it. Figures 2; references: 6 Russian. [48-2415]

UDC 669.788

HYDROGEN RESISTANCE OF VT1-0 TITANIUM UNDER 150 MPa PRESSURE AT ROOM TEMPERATURE

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 20, No 5, Sep-Oct 84 (manuscript received 19 Jan 83) pp 118-119

ARCHAKOV, Yu. I., ALEFERENKO, T. D. and TELEGIN, Yu. V., All-Union Scientific Research Institute of Petrochemical Industry, Leningrad

[Abstract] An experimental study was made for the purpose of determining the effect of high-pressure hydrogen at room temperature on the mechanical properties of VT1-0 titanium. After soaking in 99.8% pure H_2 (0.1% O_2 + 0.1% N_2) under pressure, the specimens were tested mechanically. The effect on stresses, particularly tangential tensile ones, was measured on tubular specimens of various thicknesses cut from rods with an original 0.0022 wt.% H_2

content. These specimens were held for 500 h under internal pressures up to 150 MPa matching the wall thickness. After being held for 2000 h under an external pressure of 150 MPa, 15 mm-long rod specimens 3 mm in diameter with an original 0.0049 wt.% H_2 content were tested for tensile strength in an R-5 machine with 2 mm/min displacement and 6 mm-thick strip specimens with an original 0.0015 wt.% H_2 content were tested for impact strength with an MK-30 pendulum. After these tests a microstructural examination of specimens was made, and their hydrogen content was measured by the method of melting in a stream of a carrier gas. The results indicate no change in mechanical properties and in microstructure after exposure to hydrogen under high pressure at room temperature. References 3: 2 Russian, 1 Western. [48-2415]

UDC 669.295:621.785.78:620.187.3

STRUCTURAL CHANGES WITH ONE- AND TWO-STAGE AGING OF ALLOYS Ti-Al-Mo-Fe AND Ti-Zr-V-Al-Sn

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 58, No 6, Dec 84 (manuscript received 12 Mar 84) pp 1188-1193

VASIL-YEVA, V. B. and ZAKHAROVA, M. I., Moscow State University imeni M. V. Lomonosov

[Abstract] The purpose of this work was to study the influence of one- and two-stage aging on structural transformations in alloys of the compositions 78Ti-14Al-4Mo-4Fe and 75.5Ti-7Zr-12V-4Al-1.5Sn, with two-phase ($\beta + \alpha'$)-martensite structure after hardening. The alloys were produced in an arc furnace in an atmosphere of purified argon with 6-times remelting from high-purity metals. Homogenization at 1100°C, hardening in oil and tempering at all temperatures was performed in a vacuum of 10^{-3} Pa. The alloys were studied by x-ray analysis of polycrystals, electron and optical microscopy and by measurement of microhardness. High-temperature aging at 550°C was found to cause rapid decomposition of martensite and coagulation of α crystals, decreasing microhardness. Low-temperature hardening at 350°C follows different mechanisms. In Ti-Al-Mo-Fe after one hour at 350°C a β matrix and metastable α' martensite, α'' and ω phases are present. Further heating at 350°C for 15 hours results in a decrease in rhombic distortion of α'' phase. In Ti-Zr-V-Al-Sn during tempering at 350°C, ω and α'' phase segregations are not produced. The α phase is segregated for 15 hours, accompanied by displacement of β matrix lines in the direction of greater angles, indicating enrichment of the matrix with vanadium. Two-stage aging leads to higher values of microhardness than one-stage aging if the high-temperature aging stage is begun after segregation of most of the crystals but before the beginning of coagulation. Figures 3; references: 4 Russian.
[85-6508]

WELDING

DIFFUSION VACUUM WELDING

Moscow ZNANIYE-SILA in Russian No 11, Nov 84 pp 17-18

[Article by V. Volodin "How to Weld That Which is Impossible to Weld"]

[Text] About two years ago, chemists needed a vessel of pure silver. Science, it is said, requires sacrifices. Silver is silver. But, when economists found that the vessel must be three meters high with walls about seven centimeters thick and that it would weigh the equivalent of 12 tons of valuable metal, technologists become interested in whether something less expensive could be thought of? For example, cladding, covering a thick steel sheet with a thin silver sheet, bend the two-layer intermediate product into a cylinder and weld a lengthwise seam. However, the rolling mill people stated that so far they can coat a steel sheet with stainless steel, but not with silver. Also, the vessel would have very odd shape: a cylindrical body, a funnel shaped bottom and a cap with a narrow neck. It would require the building of a special rolling mill and would cost more than silver. Nor did chemists indicate any enthusiasm for this rolled-welded version, stating that a welded silver seam would destroy the purity of the produced product. Then, the technologists offered a casting version - a cast body with silver spray-coated on the internal walls. The chemists objected again: sprayed silver would not withstand the severe chemical reaction conditions for which the vessel was intended...

Over a hundred years ago, Nikolay Nikolayevich Bernados, Russian engineer and welding inventor, energized the first welding electrode in the world.

But, along with the first electrode, there was generated one annoying paradox. This unpleasant paradox remains no matter whether metals are welded with a metal electrode manually or powder wire automatically, high temperature jet, laser beam or electronic beam!

To understand the paradox mechanism, it is necessary to look into the microcosm of the metal.

We will cut two welded pieces of metal across the welded seam. We will grind and polish the plane of the cut and look at it through a metallographic microscope. The welded seam in the transverse cut and lines on both sides of it, along which the basic metal fused with the seam metal, can be clearly seen.

The zone of the direct junction is only several tens of angstroms, while the entire seam is at least 50 million times wider. Why was such a wide seam needed? The seam itself is not needed and that is the paradox of welding! A gap is needed between the parts being welded so that the welding electrode can reach the edges and fuse them. The seam only fills the gap between the edges with fused metal. The thicker the parts, the larger the seam must be and more electrodes are required to fuse it.

This welding paradox is not so harmless. Metallurgical plants process metal into electrode wire; dozens of special plants manufacture electrodes by satisfying with difficulty the voracious appetite of welding. A huge amount of electrical power is spent on manufacturing and then fusing electrodes. In return, we obtain a metal structure far from perfect. In fusing, we make the metal so hot that undesirable structural changes occur and thermal stresses originate. To improve the metal structure and reduce stresses, it is necessary to carry out a complicated, sometimes for many hours, thermal treatment, spending more electrical power on it than on welding itself. Welding by fusing is also harmful to the environment. For example, there was such a case in Moscow. In supposedly very good clean air, the sanitation service in the rayon suddenly detected oxides of manganese and iron, nitrogen oxides, carbon dioxide and hydrogen fluoride in the air. It was found that a small enterprise, previously considered clean, had organized a welding shop, "forgetting" to install air filters.

While any technology has them, all such shortcomings were more inherent in welding from the very start and, in general, are well known. But, in the last several decades, another shortcoming in welding by fusing became obvious. More and more frequently, it posed technological problems impossible to solve.

New sectors of science and technology such as nuclear power, rocket building, high power or low temperature physics, superhigh pressures, polymer chemistry, radioelectronics and computers were developing on the basis of new metals and materials which could not be fused by welding.

For example, it is necessary to butt-join a pipe of stainless steel to a copper pipe. Welding by fusing cannot be done because it is based on dissolving one metal into another one, but copper cannot be dissolved in steel. Say it is necessary to join a steel part to aluminum, but steel melts at about 1500 degrees, while aluminum melts at a considerably lower temperature. That means that aluminum will vaporize before the steel melts. Titanium is an excellent material for airplane parts. It weighs almost half that of steel and it has high anticorrosive properties. Yet, at 300 degrees, it becomes saturated intensely with air hydrogen and the welded joint becomes as porous as a sponge. This metal sickness is called "hydrogen noise." Zirconium, so needed in nuclear power (fuel rods shells are made from it), is very strong and light, is not soluble in almost any of the strong acids, but it is very complicated or entirely impossible to weld a zirconium part to any other part. A magnetic alloy cannot be welded to ordinary steel since, when heated, the alloys lose their magnetic properties.

The "impossible" list can be continued. We are enumerating them not to say, see how bad fusion welding is. On the contrary, it is a remarkable technology and it has many fewer shortcomings than advantages. But this is dielectics. Within any technology, even the best, there is unavoidably generated something new to improve it and even replace it.

About 30 years ago, N. F. Kazakov defended a candidate's thesis in an area entirely contradictory to welding, namely, in the area of processing metal by machining. At that time, he was awarded Lenin's prize in the area of science and technology for the development and introduction into production of a new in principle method for welding metals and nonmetallic materials.

Everything began with the fact that the scientist, involved with the problems of increasing the life of machining tools, notices that at high temperature, originating at the contact zone between the tool and the part, there occurs a mutual diffusion (penetration) of the atoms between the contacting metals. This was due to the huge pressure that developed in the contact zone. This occurred although their surfaces do not fuse!

But how can welding be "made" from this?

The creation of such high pressure was out of question. When the unit pressure, originating at the sharp edge of the cutter was recalculated, for the area of the edges being welded, even for a small part, it was found that to butt-weld, for example, an aluminum pipe to a copper pipe, it would be necessary to compress them with a 900-ton force. Why, at that force it would simply be converted to a tablet!

Perhaps, the ends of pipes should be ground more thoroughly in order to reduce the irregularities, and thereby facilitate bringing the surfaces closer together? Perhaps, then such high pressure would not be needed? But ground and even polished metal only appears smooth. Under a microscope, it may be seen that as compared to the hills and valleys on its surface, an atom is just a pea at the foot of the Ostankino remote control tower.

Perhaps try to activate the atoms by heat anyway? Not to the fusion temperature, as in electrical welding, but by several hundred degrees? The heat must increase the oscillation amplitude of the atoms at the nodes of the crystal lattice. Will that enable them to jump across the boundary?

Two steel samples were ground thoroughly, the surfaces were degreased, they were heated, compressed tightly together and ... no weld was produced. The heated surfaces of the samples became oxidized in the air and no diffusion was obtained. The oxide films did not liberate even one atom from the surfaces being joined.

Here the investigators had an idea that now seems simple and obvious: the parts to be welded must be heated in a vacuum chamber! The very first tests indicated that the scientists were on the right track.

The new method for joining metals and nonmetallic materials (in the very first tests it was possible to join metal even with procelain) was called diffusion welding in vacuum.

This method may be called welding only by tradition, since here nothing was melted, boiled or cooked. A vacuum, low heat and low pressure replaced traditional fusing. Here, the vacuum not only protected the part from oxidation by air, but also produced conditions which sublimated from their surfaces the thinnest films of oxides or moisture that were on them before being heated.

Now, neither N. F. Kazakov, nor his oldest staff workers can recall what was the first part to be welded. This really is of no special importance. However, they remember everything about the period of wonderful discoveries and most interesting research that began 20 years ago. The museum of the Scientific Research Problems Laboratory of Diffusion Vacuum Welding -- thus was named a scientific-production subdivision created for research in this area and for introduction of results in industry, -- now collected thousands of exhibits. Each one of them is not simply an exhibit, but is a part or device that is in operation in a shop of a plant, in a nuclear electrical power plant or a laboratory of an experimenter.

Each one of them made it possible for production facilities or scientists to take a step forward in a new development stage.

"At first," recalls N. F. Kazakov, "something like a gold fever seized the staff workers. They welded everything they could get hold of, which previously could not be welded by any method. Steel to aluminum, aluminum to cast iron, silver to stainless steel, copper to iron, glass to titanium, ceramics and porcelain to magnetic alloys and bronze to steel."

As the number of experiments grew, so did the number of failures. Some metals welded so that it was impossible to see the boundary between them even under a microscope. Others also welded pretty well, but a boundary and a transition zone could be seen on microsections. Still others welded only at individual surface sections and there were some that could not be welded at all. It became necessary to investigate the causes thoroughly and substantiate the mechanism of a diffusion joint scientifically. A metal crystal contains deviations from the ideal disposition of atoms in its lattice. Atoms move in the crystal in the process of plastic deformation. These deviations from the ideal order, that make it possible for atoms to migrate, are called dislocations. The possibility of plastic deformations is determined by the presence of dislocations in the metal crystal, or their origination under a mechanical load and by their density. The availability and origination of dislocations is one of the conditions for diffusion welding.

Nature permits carelessness in work. Some nodes in the lattices are found to be vacant; such defects are called vacancies. Such free locations in crystals also facilitate diffusion.

Investigators divided diffusion vacuum welding conditionally into two stages. In the initial surface contact, plastic deformation of irregularities occurs as does the destruction of the very thin films of adsorbed gases or moisture. After the origination of the mechanical contact begins, there is a second stage of the process in which the movement of vacancies and dislocations and the mutual diffusion lead to the destruction of the boundaries between the surfaces being joined.

Thus, was defined the basic principle of joining parts from different metals and materials. For example, the parts are fairly massive and can withstand large forces when compressed. In this case, plastic deformation of the irregularities will occur rapidly and the formation of atomic ties is possible even in the first stage of the process. If, however, the parts are thin, the material is fragile and high pressures are impossible, the contact time must be increased. If the welded materials differ considerably in their physio-chemical properties, for example, the atoms of one material are much too large to be introduced into vacancies of the crystal lattice of another material, an intermediate layer can be used with average parameters of the crystal lattice.

At present, diffusion vacuum welding is being used in almost 800 enterprises in the country. Over 600 pairs of the same or different metals and materials are being welded. Of these, there are over 500 that previously could not be welded by any of the known methods. The silver vessel, with which we began our story, was made in due course precisely by the diffusion method.

Diffusion welding is very, very unique. Only soldering could, perhaps, compete with it, if soldering did not require solders made of gold, platinum, silver or brass and the solder connections were as strong as the materials being joined.

Diffusion welding is very economical. It does not need electrode wires, fluxes, protective gases and the joints, as a rule, are stronger than the metals being joined.

The parts do not require following machining or thermal treatment.

Diffusion welding is ecologically clean. There are no emissions of radiation, harmful gases or aerosols. It is absolutely harmless to workers. Is this not a criterion of the highest quality for a modern technological process?

To illustrate the possibilities that diffusion welding opens up to industry, it is sufficient to cite several examples.

Dies faced with special alloys, that previously could not be joined to a steel base, now operate 50 to 60 times longer than the usual ones, while being only half as expensive.

Metal conductors, welded in quartz glass (specifically welded and not covered with liquid glass, as usual), made it possible to create an entirely new class of high temperature electrical vacuum devices.

Cutting tools made of the most inexpensive steel, but with metal-ceramic plates welded to them, machine the hardest and even hardened steels at unprecendented high speeds.

Half-meter long platinum electrodes operate in chemical reactors which at the same time are catalysts. Of course, they are not made entirely of platinum (then they would have been more expensive to manufacture than the products made in the reactor); a platinum disk only 20 microns thick is welded to a massive disk made of stainless steel.

And, finally, the crown of the new technology which disproves opinions existing even today that diffusion welding is suitable only for small parts and devices. A device 84 meters long and a meter in diameter was manufactured at the Tambov "Komsomolets" Chemical Machinebuilding Plant. Its housing is diffusion welded of three layers of various metals!

In recent years, the Problems Laboratory Collective created 75 various types of equipment, including automatic and semiautomatic, for diffusion vacuum welding. Over 100 inventions were made at the laboratory. The economic effect, taken into account only recently, exceeded 100 million rubles.

2291
CSO: 1842/49

COLD SHEAR-WELDING METHOD

Riga SOVETSKAYA LATVIYA in Russian 3 Feb 84 p 2

[Article by A. Popova]

[Excerpt] A method of cold shear welding which specialists of the Latvian State University have developed permits rapid and comparatively economical installation of wiring. This type of welding is based on the principle that the thin surface film of a metal breaks down from the effect of even comparatively small loads on the metal. Copper and aluminum and silver and tin adhere to one another through microcracks and fractures that form in this film.

As compared with other types of welding, the new method has a number of advantages: it is cleaner, does not require large amounts of electricity, is less laborious, and permits work to be done with a large assortment of materials. Moreover, the joining of wires to terminals in this manner reduces contact resistance by almost 25 percent while at the same time increasing the materials' corrosion resistance.

This new process, which the Latvian scientists developed under the direction of Candidate of Technical Sciences A. Pranch and with the participation of specialists of the Ukrainian Academy of Sciences' Institute of Electric Welding imeni Paton, has been successfully tested in power-line sections of the Donets Railroad.

FTD/SNAP
CSO: 1842/96

TESTING OF ROBOTIC WELDING COMPLEX

Leningrad LENINGRADSKAYA PRAVDA in Russian 6 Feb 85 p 1

[Text] A robotic complex, the testing of which has begun at the All-Union Scientific Research, Planning-and-Design and Technological Institute of Electric Welding Equipment, can be three times as productive as the most skilled welder. This is the first industrial model of automatic, quickly resettable units, the series production of which the Leningrad plant "Elektrik" is beginning this year in line with the "Intensifikatsiya-90" program.

Quite a few robots for welding operations have been developed both in our country and abroad. The institute's specialists have developed a design which incorporates the best features of earlier machines. The new complex can operate both independently and as part of flexible automated production lines. It is not necessary to develop a complicated program for it. All that the operator needs to do is to go through the entire welding process with the robot just once, and subsequently the complex will operate 'from memory.'

Personnel of the Vil'nyus Electric Welding Equipment Plant, where the first test prototype of this automatic 'welder' is in operation, have given the new equipment high praise.

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UDC 621.791.4.052:669.295:620.17

WAYS OF IMPROVING LEVEL AND STABILITY OF MECHANICAL CHARACTERISTICS OF DIFFUSION-WELDED JOINTS OF OT4 TITANIUM ALLOY

Kiev AVTOMATICHESKAYA SVARKA in Russian No 11, Nov 84 (manuscript received 9 Jan 84, in final form 29 Apr 84) pp 39-43

PESHKOV, V. V. and RODIONOV, V. N., candidates of technical sciences, Voronezh

[Abstract] Improving and increasing mechanical characteristics of diffusion-welded joints is imperative because of current variations in mechanical properties attributed in part to microstructural irregularities. The present article reports on a new theoretical approach to resolving these problems and its experimental verification using the common OT4 titanium alloy. Various shapes tested showed that globularly structured alloys had the least resistance to deformation, and plate-like structures with clear boundaries of the original beta-granules had the most resistance. Factors of creep during welding, physical contact and surface activation, and chemical bonds are discussed. Recrystallization was found in alloys with even axial structures and those with prominent alpha-granules. The quality of joints with any given welding procedure was closely tied to the initial microstructure, with the weakest part of the joint found between different structural types. Selection of welding pressure and other parameters made it possible to obtain joints that consistently fractured at the basic metal, rather than the seams. Figures 4; references: 7 Russian.
[60-12131]

UDC 621.791.4:589.378.3

RESIDUAL OXYGEN PRESSURE IN CONTACT GAP UPON DIFFUSION WELDING OF TITANIUM

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 11, Nov 84 pp 6-7

PESHKOV, V. V., candidate of technical sciences, Voronezh Polytechnical Institute

[Abstract] Production of a quantitative estimate of the gas pressure in the contact gap during diffusion welding of titanium as a function of technological parameters is an important problem, since it allows a judgment to be made concerning the mechanism of cleansing of the welded surfaces of scale and an estimate of the degree of rarefaction of air in the vacuum chamber. This problem is solved in this article by analysis of a model of the contact zone and description of processes occurring in it during diffusion welding. The mathematical model used produces an equation which can be used to estimate the concentration of gas in the contact gap and analyze the influence of temperature, gap width and oxygen partial pressure in the welding chamber on depth of penetration of oxygen into the contact zone. Figures 4; references: 5 Russian.
[79-6508]

UDC 621.791.052:669.017.3:620.178.2

BRITTLE FRACTURE RESISTANCE OF ELECTRON BEAM-WELDED JOINTS IN TITANIUM α ALLOYS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 12, Dec 84 pp 4-5

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[Abstract] In spite of high impact toughness, certain high-strength titanium α alloys have a tendency toward brittle fracture under normal operating conditions and static loads. Alloys types VT5, AT6, TS5 and VT20 were electron beam welded, 18 mm of thickness per pass following abrasive disk cleaning and degreasing with acetone. Specimens were annealed at 750 to 880°C for one hour and notched in the root portion of the seam by an electric erosion method with a brass wire 0.2 mm in diameter. The hardness and impact toughness were measured in various sections of the joint. The brittle fracture resistance was found to decrease, the transition temperature of the seam metal from the brittle to the tough state to increase in static bending tests. Annealing for relief of residual stresses increased the crack development resistance in VT5 alloy, decreasing it in TS5 and VT20. Static bend testing is found to be a more rigid test for these alloys than ordinary impact bending. Electron beam welding does not increase the crack resistance of the seam metal in these alloys. References: 5 Russian.
[78-6508]

UDC 621.791.72.052:669.295

INCREASING SEAM FORMATION STABILITY IN ELECTRON BEAM WELDING OF VERY THICK TITANIUM ALLOYS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 12, Dec 84 pp 1-2

OL'SHANSKIY, N. A., doctor of technical sciences (deceased), LOPATKO, A. P., candidate of technical sciences, PETRENKO, V. R., candidate of technical sciences and TOLOKONNIKOV, N. P., engineer

[Abstract] In electron beam welding of thick titanium alloy structures by a horizontal beam, metal flows from the channel, forming cavities and discontinuities sometimes reaching one-third the volume of the melted channel. These defects can be eliminated by observing proper welding conditions, based on analysis of the seam formation mechanism. This article presents a mathematical study of the mechanism, representing the welding bath as a fluid moving in a cylindrical channel open on both sides and acted upon by internal pressure equal to the sum of the vapor pressure and hydrostatic pressure. The forces of surface tension acting on the drop flowing out of the channel

must retain the fluid. The mathematical fluid model of the process suggested allows the possibility of stable and defect-free formation of the seam to be computed, depending on the position of the beam focus, slope angle of the melting channel, vapor pressure gradient and thermophysical properties of the metal. Figures 4; references: 4 Russian.
[78-6508]

UDC 621.791.754'.293

DEVELOPMENT OF COATING FOR PROTECTION OF BACKSIDE OF SEAM IN WELDING OF TITANIUM ALLOYS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 12, Dec 84 pp 22-24

MOZEYKO, B. Yu., engineer, BAZHENOV, V. V., doctor of technical sciences and DEGTYAREV, I. Ya., engineer

[Abstract] Results are presented from studies intended to increase the reliability of protection of the backside of a seam during welding of titanium alloys outside of a controlled atmosphere chamber by creation of a strong protective coating. Experiments were performed on sheets of VT20 alloy 2 mm thick. The coating was made from oxygen-free halides, specifically alkali and alkali earth metal fluoride-chloride mixtures which had been heated for 2 hours to 523°K. The composition of the coating charge was 12% $CaCl_2$, 4% NaF, remainder CaF_2. The charge was mixed with a volatile acetone plus ethanol mixture to produce a paste which was easy to apply. Thermodynamic calculations indicate that the most probable reaction between coating and base metal is the reaction between aluminum and sodium fluoride, which becomes possible at 1850°K. Due to the low activity of the aluminum in the alloy, the yield of this reaction is slight, so that it does not influence the final content in the alloy. This yield is confirmed by direct elemental microanalysis of the seam metal. The calculated values of activity of the components of the Ti-Al system at 2000°K allow computation of the interaction upon welding of alloys based on this system. The method of introduction of the binder component to the two-layer coatings significantly increases the strength of the coating and allows it to be used under genuine industrial conditions. The content of gases and carbon in the welded joint metal is within the permissible limits. Figures 5; references: 9 Russian.
[78-6508]

UDC 621.791.4.539.378.3

STRUCTURE AND MECHANICAL PROPERTIES OF DISPERSION-HARDENED NICKEL ALLOY JOINTS WELDED BY DIFFUSION

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 11, Nov 84 pp 15-17

KARAKOZOV, E. S., doctor of technical sciences, TERNOVSKIY, A. P., candidate of technical sciences, SAMSONOVA, T. S., engineer, DAVID'YAN, E. V., engineer, and BABICH, B. N., candidate of technical sciences, Moscow Evening Metallurgical Institute

[Abstract] A study is made of the influence of the major parameters of welding on accumulated deformation and kinetics of formation of physical contact in diffusion welding of the dispersion hardened nickel alloy VDU-2. The kinetics of growth of relative strength and relative elongation of joints welded at 780, 820, 860 and 900°C with compressive forces of 65, 70, 75 and 80 MPa were determined. With increasing welding time the dimensions of defects in the welded zone decreased significantly, practically disappearing at 30 minutes. The recommended temperature for the process is 860-900°C with loading applied over a period of at least 15 minutes. Figures 5; references: 4 Russian.
[79-6508]

UDC 621.791.75:007.52.001.24

STUDY OF EXPERIMENTAL ROBOTIZED SYSTEM FOR ARC WELDING BASED ON "Universal-15" MANIPULATOR

Kiev AVTOMATICHESKAYA SVARKA in Russian No 11, Nov 84 (manuscript received 25 Nov 83, in final form 15 Feb 84) pp 33-38

TIMCHENKO, V. A., BONDARENKO, A. I., DUBOVETSKIY, S. V., candidates of technical sciences and SKORINA, V. N., engineer, Kiev; KARGASHIN, A. Yu. and BULATOV, V. E., engineers, Moscow

[Abstract] The Ye. O. Paton Institute of Electrical Welding, in cooperation with other organizations, has developed the robotized arc welding system described in the present article. The system, which is diagrammed and described, features the "Universal-15" manipulator with six types of motion, including two directional and four rotational functions. For welding purposes maximum movement speeds have been reduced by a factor of 4 in the "Universal-15." Programming and program implementation have concentrated on selecting position for stock and arc, preparing the robot to follow given welding procedures, and monitoring and correcting motion of the welding torch. Experimental operation has shown that the greatest variations from specifications were brought on by instability of clearance, resulting in seam irregularity, and excessive tolerances in electrode diameter. The authors suggest that official state standards (GOST) permit too much tolerance in welding operations. Figures 6; references: 6 Russian.
[60-12131]

UDC 621.791.754'293:669.715:621.3.014.31

DYNAMIC CHARACTERISTICS OF AC ARC IN WELDING ALUMINUM ALLOYS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 11, Nov 84 (manuscript received 13 Sep 83, in final form 14 May 84) pp 30-32

KOROTKOVA, G. M., candidate of technical sciences, Togliatti Polytechnical Institute

[Abstract] Increasing the stability of secondary arc activation during welding of aluminum alloys with alternating current through a non-melting electrode involves a number of static and dynamic factors which are the subject of the present article. Tests were made of AMg6 alloy, welded in a current range of 60-400 amperes in an argon medium. Resistance was 0.02-0.16 ohms in the negative, and 0.03-0.26 ohms in the positive segment of the current; with change in polarity, these values were 0.2-1.11 ohms in the negative and 0.58-1.8 ohms in the positive segment. Special stabilizers were used to regulate the arc. Consistent secondary activation depended on the duration of transitional processes, with the least values for sinusoidal current being reached at above 70 amperes; below that, stabilizer function was too limited to maintain secondary arc activation. Figures 5; references: 5 Russian. [60-12131]

UDC 621.791.052.4:539.4.014

EVALUATION OF STRESS CONCENTRATION COEFFICIENTS IN BUTT-WELDED JOINTS WITH DISPLACED EDGES

Kiev AVTOMATICHESKAYA SVARKA in Russian No 12, Dec 84 (manuscript received 15 Dec 83) pp 11-13

SHAKHMATOV, M. V., candidate of technical sciences, VOROB'YEV, I. A. and BOGOSLOVSKIY, S. V., engineers, Chelyabinsk Polytechnical Institute

[Abstract] Edge displacement in welding is a very common defect that causes excessive concentration in joints and, consequently, early failure. The present article reports on an evaluation of stress concentration coefficients in such welded joints in relation to their geometric parameters, such as deviation from the transitional radius from seam to basic metal and seam width. A final element method was used to simplify calculations of stress in various welded joints in order to consider interrelations between basic geometric parameters. Results showed that with small values for the transitional radius from seam to basic metal (< 0.6) and with displacement greater than 0.2, stress concentrations can reach significant levels. Seam width was not an important factor. Experimental results coincided with calculations of the stress concentration coefficients. Figures 5; references: 10 Russian. [53-12131]

UDC 621.791.4:669.71

PRESSURE WELDING OF CORROSION-RESISTANT STEEL WITH AMg6 ALUMINUM

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 12, Dec 84 pp 10-12

SAPRYGIN, V. D., candidate of technical sciences, SOKOLOV, V. I., engineer, ONOSOVSKIY, Ye. V., candidate of technical sciences, KARAKOZOV, E.S., doctor of technical sciences and ZOTIN, V. I., candidate of technical sciences

[Abstract] The authors have developed a technology for manufacture of aluminum plus steel (AMg6+12Kh18M10T) pipe junctions by heat and pressure welding. The method involves bringing the heated parts together with significant force and with a wire of a softer material between them. Photographs of aluminum-steel transition pieces manufactured by the method are presented. The quality of the welded joints produced was estimated by testing of specimens loaded in extension until separation occurred. Separation occurred at the softer AMts insert material. The most important parameters in the welding method are the cone angle of the contacting end surface on the aluminum alloy, 5°, circular projections with a tip angle of 60°, height 0.75 mm and spacing 1.0 mm on the end surface of the steel parts, temperature 673°K, degree of formation of intermediate softer insert 70-80%, pressure 600-650 MPa. Residual stresses and relaxation processes are found to influence the formation of the welded joint. The specimens are found to be satisfactory for production of cryogenic equipment. Figures 5; references: 7 Russian. [78-6508]

UDC 621.791.754'293.002:669.715-415

EFFECTIVENESS OF USE OF HEAT-DISSIPATING CLAMPS TO REDUCE DEFORMATION DURING ARGON ARC WELDING OF THIN SHEETS OF AMg6 ALLOY

Kiev AVTOMATICHESKAYA SVARKA in Russian No 12, Dec 84 (manuscript received 2 Mar 84, in final form 20 Apr 84) pp 43-45

ZHDANOV, I. M., candidate of technical sciences, MEDKO, B. V., LYSAK, V. V. and NIFANTOV, V. N., engineers and DYKHNO, S. L., candidate of technical sciences, Kiev

[Abstract] Heat and force interactions generally cause deformations during welding of thin AMg6 alloy sheets. The present article reports on study of transverse contraction when heat-dissipating clamps are used to control sheet position. Mechanical measurements were made with deformometers with 25, 50 and 100 mm bases, at various times during welding. Results showed that contraction began during initial heating, long before the heat source approached the weld site, and reached its maximum after the arc focus passed the weld site. Contraction could be reduced by using highly concentrated energy sources, as well as by use of heat-dissipating equipment such as the clamps tested. It was possible in this manner to reduce shrinkage below that found in microplasma welding and close to that in laser and electron arc processes. Copper clamps provided the best heat dissipation. The clamps were most effective when located very close to the weld site. Figures 3; references 9: 8 Russian, 1 Western.
[53-12131]

UDC 621.791.4.052:[669.14.018.295+669.14.018.87.620.17

DURABILITY OF JOINTS OF 30KhGSA and 12Kh18N10T STEELS MADE BY DIFFUSION WELDING

Kiev AVTOMATICHESKAYA SVARKA in Russian No 12, Dec 84 (manuscript received 17 Feb 84, in final form 3 Jul 84) pp 46-49

KAZAKOV, N. F. (deceased), doctor of technical sciences and TRIFONOV, V. A., engineer, Moscow Institute of Aviation Technology imeni K. E. Tsiolkovskiy, NIKOLAYENKO, V. V., VARYANITSA, V. Yu., candidates of technical sciences aad YERMAKOV, N. V., engineer, All-Union Interdisciplinary Scientific Research Institute for Protecting Metals from Corrosion

[Abstract] Use of various metals for economy in industries such as electrical energy production requires that welded seams be as strong as the basic metals. The present article reports on vacuum diffusion welding of 30KhGSA and 12Kh18N10T steels, selected for their general strength and the nature of failures when they do occur. The test welding was done at 1470°K at a rate of

20 minutes/meter and pressure of 10 MPa. Results showed that at the 1470°K temperature, considerable metal creep was encountered, but a durable seam was obtained. Later failure occurred in the 12Kh18N10T steel with classic cone-cup form. Metallographic study showed the presence of a transitional zone where the metal had less etching and greater microhardness. This zone was formed by decarbonization of the 30KhGSA steel and penetration of chromium, titanium and nickel into the zone. The transitional zone, with a width of 10-15 microns, assured a durable joint of the test steels. Figures 5; references: 4 Russian.
[53-12131]

UDC 621.791.4:539.378.3:061.3(47+57)

ELEVENTH ALL-UNION SCIENTIFIC AND TECHNICAL CONFERENCE "DIFFUSION WELDING OF METALLIC AND NON-METALLIC MATERIALS"

Kiev AVTOMATICHESKAYA SVARKA in Russian No 12, Dec 84 pp 67-68

TRIFONOVA, N. A., engineer

[Abstract] The conference, held in Moscow 24-25 May 1984 under sponsorship of the Ministries of Higher and Secondary Special Education of the USSR and the RSFSR and the Moscow Institute of Aviation technology imeni K. E. Tsiolkovskiy, involved academic and practical workers. The rector of the Institute, Professor B. S. Mitin, delivered the keynote address. Topics covered in papers at the conferences included state and prospects of diffusion welding of mixed materials for economy and efficiency, composition and refractory materials for aviation and astrophysical use, alloys with and without tungsten for various applications, nickel-based refractory alloys, bimetal unions and chemical and mechanical reactions in such laminates, ceramic, glass and ferrite joints with metals, powder and composition coatings for metals, oxide reactions with various metals in such combinations, and electron arc and impulse welding in combination with diffusion processes. Problems of equipment development and personnel preparation were also addressed. Recommendations were made on directions for further research in each of these specific types of welding processes and applications.
[53-12131]

UDC 621.791.052.01:548.5:622.648

COLD RESISTANCE AND FRACTURE RESISTANCE OF WELDED JOINTS IN GAS LINE PIPES

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 11, Nov 84 pp 4-5

GORITSKIY, V. N., candidate of technical sciences and BOLOTOV, A. S., candidate of technical sciences, All-Union Scientific Research Institute of Pipeline Construction, Moscow

[Abstract] Results are presented from testing of two types of pipe based on steel types 09G2FB and 16G1S. Specimens 1420 and 1020 mm in diameter with nominal wall thickness 17.5 and 12 mm, operating pressure 7.5 and 5.5 MPa, minimum permissible usage temperature -15 and -5°C, were tested. Cold resistance was estimated on the basis of the brittleness temperature. Studies showed that welded seam strengths were equal to or even superior to base metal strengths. The test method allows comparative evaluation of cold resistance and resistance to propagation of fractures by simultaneous initiation of a crack in the welded seam and the base metal of a pneumatically loaded pipe with subsequent determination of the characteristics of the fracture. It is shown that fulfillment of the standards for metal of longitudinal gas line pipe seams in terms of impact toughness and ductility provides good cold resistance and resistance to the propagation of both brittle and viscous fractures. The instability of propagation of fractures, consisting of deflection of a crack from the welded seam into the base metal, allows serial field testing to establish the nominal value of impact toughness of the seam metal from the moment of transition of the fracture from unstable to stable. Figures 2; reverences 7: 5 Russian, 2 Western.
[79-6508]

UDC 621.791.3:052:669.017.3

DISTRIBUTION OF BORON IN SOLDER JOINTS OF NICKEL HEAT-RESISTANT ALLOYS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 12, Dec 84 pp 6-7

BERZINA, I. G., doctor of physical-mathematical sciences, GUSEV, E. B., candidate of physical-mathematical sciences, DRUSHITS, A. V., engineer, IVANOV, V. A., engineer, and RYL'NIKOV, V. S., candidate of technical sciences

[Abstract] Results are presented from studies of the distribution of boron in structure elements of solder joints in heat-resistant nickel alloys made with boron-containing solder with various degrees of diffusion interaction of the solder and base material. Nuclear physical elemental analysis methods were used in the study. Specimens were used with flat polished surfaces to which a cellulose nitrate detector was firmly attached. The specimen and detector were bombarded wtih thermal neutrons in a reactor channel. The maximum neutron fluence was not over 10^3 n/cm^2. After bombardment the detector was

selectively chemically etched in aqueous NaOH at 70°C for 1 to 3 minutes, so that the detector revealed traces of the products of nuclear reaction $^{10}B(n,\alpha)^{7}$ Li. The study of local boron concentrations in the solder joint of the specimens showed that boron is distributed nonuniformly in the seam and diffusion zone. The high concentration gradient does not provide the needed joint strength. Long-term isothermal holding after soldering achieves more uniform distribution of boron in the area of the solder joint. Figures 3; references: 2 Russian.
[78-6508]

UDC 621.791.76:669.14.018.44

CONTACT POINT AND SEAM WELDING OF HEAT-RESISTANT ALLOYS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 12, Dec 84 pp 8-10

SHORNIKOV, V. M., engineer and RAKCHEYEV, V. N., engineer

[Abstract] Heat-resistant nickel and iron-nickel-based alloys, due to the broad temperature range of crystallization resulting from their complex chemical composition, frequently form defects when welded. The high resistivity of the alloys causes the rapid increase in temperature at the contact point between parts, leading to a delay in the process of formation of the plastic face relative to melting of the metal. It is particularly difficult to produce stable joint dimensions. Increased pressure leads to an increase in the contact area between electrode and part and between the two parts, decreasing heat liberation and requiring an increase in current. Stable, defect-free welds can be achieved only by smooth, continuous heating to assure optimum matching of the processes of temperature increase and rate of softening of the deformed metal. DC welding machines are best suited. Experiments were performed on KhN56VMTYu alloy, indicating that with great pulsations the core diameter develops largely in the plane of contact, since heat liberation to the electrode is increased, and melting increases more slowly. The diameter of the cast spot is less when pulsations are greater.
[78-6508]

UDC 621.791.4

THERMOCOMPRESSION WELDING OF PARTS MADE FROM AMts AND VT1 ALLOYS

Moscow SVARCHNOYE PROIZVODSTVO in Russian No 7, Jul 84 pp 27-29

MAMUTOV, Ye. L., candidate of technical sciences and TIKHOMIROV, E. A., engineer

[Abstract] Welding of titanium with aluminum by melting is difficult due to the significant differences in their physical and chemical properties.

Thermomechanical methods such as diffusion and thermal compression are therefore promising. This work attempts to determine the possibility and specifics of thermal compression welding of AMts aluminum alloy with VT1 titanium alloy. A mathematical model of the process is constructed, describing the quantitative variation in yield point in extension of joints as a function of factors influencing the welding pressure. It is shown that the qualitative conceptions concerning the mechanism of formation of joints agree with empirical opinions concerning the mechanism of formation of thermal compression joints, according to which joint strength depends on the degree of compression while being determined by geometric and kinetic interactions during plastic deformations. Figures 2; references 5: 4 Russian, 1 Western. [138-6508]

UDC 621.791.052:620.17:669.71

MECHANICAL PROPERTIES OF WELDED JOINTS OF 1201 ALUMINUM ALLOY

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 7, Jul 84 pp 29-30

RYAZANTSEV, V. I., candidate of technical sciences, TOLKACHEV, Yu. I., engineer, ROSHCHINA, A. S., engineer, and OL'KHOVICK, R. G., engineer

[Abstract] A study is made of the mechanical properties of specimens of type 1201 aluminum alloy, which is similar to type 2219 alloy. Specimens 6 mm thick were cut from sheets, from hot-rolled plates 30 mm thick and from forged and rolled plates 80 mm thick as well as large forgings. Specimens were welded along and across the rolling direction as well as through the height of the rolled products. Both manual and automatic welding in argon with AC and automatic welding in helium with DC were used. Welding wire was always type 1201 (2 mm in diameter). Surfaces were prepared by manual scraping. The highest and most stable strength and ductility properties were achieved by welding with DC under helium in two passes (one without and one with wire) with cooling to 18-30°C between passes. The strength of joints made of the surface layers of the plates was significantly higher than that of joints in specimens cut from the core of the plates. The strength of joints welded across the fiber was 15 to 18% MPa higher than that obtained by welding along the fiber. The use of blanks with fiber in the direction of height in the welded zone results in a great decrease in strength and ductility. Welded joints with the seam root removed have the highest static and cyclical strength characteristics. Welded joints made of pressed strips have greater dispersion of strength and ductility properties and are not recommended for use. References: 6 Russian.
[138-6508]

UDC 539.4

EFFECT OF PROTECTIVE ATMOSPHERE COMPOSITION ON DURABILITY OF WELDED JOINTS OF NIOBIUM ALLOYS

Kiev PROBLEMY PROCHNOSTI in Russian No 11, Nov 84 (manuscript received 27 Sep 83) pp 112-118

RABKINA, M. D., NERODENKO, M. M., GUREVICH, S. M. (deceased), UMANSKIY, E. S., KHARCHENKO, V. K., KRIVENYUK, V. V., CHOLOVSKIY, G. E., PETRUNIN, G. D. and CHUGAY, N. F., Institute of Electrical Welding imeni Ye. O. Paton, and Institute of Problems of Strength, UkSSR Academy of Sciences, Kiev

[Abstract] In welding niobium alloys, protective atmospheres usually contain gases that can become impurities in the welded joint. The present article reports on a study of high-temperature durability under brief and prolonged loads with unalloyed niobium and Nb-Zr-C and Nb-W-Mo-Zr alloys. Tests were conducted at temperatures of 293-1300°K at atmospheric pressure or 2.5-4 MPa vacuum, with controlled distortion and time periods. Sharply differing durability maxima were noted. Deformation aging showed a peak at 875°K. Results showed that weld seams contained oxygen and nitrogen impurities at intermediate temperatures, and durability peaks were accompanied by reduced plasticity. Reduction of welding speed brought increased interaction between metal and gas impurities. Added amounts of nitrogen in the protective atmosphere brought increased nitrogen and oxygen in the solid phase, as well as formation of an additional phase. Oxygen was found to promote elimination of carbon and to retard decomposition of the solid solution. Development of brittleness was determined by precipitation of zirconium oxides instead of carbides at crystallite boundaries. Oxygen content below 0.03% in the weld seam had little effect, but above that content low-temperature plasticity and impact strength declined. Figures 5; references 22: 18 Russian, 4 Western.
[69-12131]

MISCELLANEOUS

ELECTRICAL PULSE CUTTING DESCRIBED

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 6 Dec 84 p 4

[Article by L. Rodzinskiy "Lightning in Metal"]

[Text] The scientist drew a wavy line on a sheet of metal and pressed to it contacts of conductors leading to it from a generator. A switch is turned and a clap is heard in the laboratory sounding like an echo from a faraway explosion. And here in my hands, I have two halves of a sheet separated along the complicated drawn curve.

"We did not have to revolutionize physics to propose this metal cutting and layout method," stated G. Okomishnikov, candidate of physico-mathematical sciences" as he smiled. At its basis is a phenomenon that was known in the last century. We encounter it practically every day..."

I had to agree. The incandescent filament of an electric bulb and the spirals of heaters remind us constantly that metal heats up when current flows through it. Already, in this century, investigators have established that metal heats up irregularly. Much heat is especially liberated when the metal surface has defects -- cracks, blisters, scratches and "foreign" inclusions. Briefly, it is those "destroyers" of the uniform metal structure that produce electrical resistance. With this conclusion, electrical equipment makers began to demand far more uniform materials from metallurgists. Some of them complained that defects on the surface of a bar may be transferred to parts from which it was made and cause breakage. To avoid this, workers in casting shops burn out defects with gas cutters. At present, plasma and scarfing machines free the workers from hard manual labor. But even these automated machines waste a large amount of suitable metal.

One could wonder how this problem would be of concern to new methods for metal layouts? Especially to scientists of the Physio-Technical Power Problems Department of the Ural Science Center of the USSR Academy of Sciences, where one of the laboratories is headed by G. Okonishnikov. The answer is simple. Laboratory staff workers established the fact that metal in the defect zone heats up especially intensely with intermittent pulsed current feed. They suggested that this phenomenon be used.

"By selecting the power and the period of the electrical pulse, it is possible to heat the metal in the defect zone to any temperature up to the point where it begins to melt," stated the scientist. "The basic mass of the bar remains relatively cold. Around the defects, however, miniature fusion centers seal blisters, cracks and scratches. The metal heals itself..."

The method proposed by the scientists makes it possible to avoid cleaning castings, reduces metal losses and improves the productivity of labor sharply. The following step of the investigators was logical.

"When a useful idea appears, it must be looked at thoroughly," stated G. Okonishnikov. If metal is heavily fused in the zone of cracks and scratches, cannot this process be made explosive? It was found that this is possible. It is necessary, for example, to scratch a line on the intermediate product sheet and "hit" a needed pulse, and an "eruption" of metal will occur along this line. The sheet will be cut instantaneously..."

By using this method, it is possible to produce parts of the most complicated shops from sheet metal. A cutting tool becomes unnecessary and wide possibilities open up for automating the process.

"It is possible to direct the electrical field so that even scratching a line will not be necessary; it will be sufficient to draw it with a pencil," finished the scientist. "But, in principle, it is possible to do without lines in general, but equip the installation with a programed control system which would make contact along the entire trajectory. It will "explode" the metal step-by-step, leaving behind a smooth, even cut."

2291
CSO: 1840/47

IZHORSK PLANT FORGES CYLINDER FROM 360-T INGOT FOR POWER INDUSTRY

Moscow OGONEK in Russian No 3, 12-19 Jan 85 p 10

[Article by O. Petrichenko]

[Text] They took the ingot out of the furnace and it was as if the sun had risen in the gloomy firmament of the huge forging shop, which was chilled by an unusually early frost. Three hundred and sixty thousand kilograms of red hot metal, exuding heat, instantly changed the microclimate. Biting cold droplets--either rain or fine hail--hit one's face, followed by a dry, almost desert-like wind in an unyielding blast.

The lifting cranes approached, rumbling and weighted by chains, and quickly, but skillfully and precisely upturned the ingot, which, gleaming and giving off sparks, floated toward the giant press, already anticipating its truly heroic work.

The abundance of superlatives in the beginning of this report is not just a whim, but a special "production" requirement, because everything related to this forging--an outstanding achievement for Soviet industry--is overwhelming in scope, size, and substance.

The new record set by metallurgists in the A. A. Zhdanov Izhorsk Plant in Leningrad, the first 360-t ingot produced, is significant for all Soviet power machinery. These blanks can be used to make one-piece shafts for rotors in turbines and generators with up to a million watt capacity; this is a direct gain in quality and economy as compared with previous welded shafts, composed of several small ingots. There is also a benefit in terms of time: a welded rotor takes almost two years to produce, but the new technology cuts this time in half.

Three years ago, at the end of 1981, the appearance of the ingot's 290-t forerunner was celebrated here. We had never produced anything like it before and, now these, unique as they were, went into serial production. The extra 70-t added by the Izhorsk workers was not simply the next step in adding weight to the earlier result, but a qualitatively new level in the production process. Time constraints imposed on solving the problem made it even more complicated. But the work done by the enterprise's collective and specialists of the Central Research Institute for Machinery Production was noteworthy, not just because of the minimum amount of time and the high level of creative power.

It took nine melts in six melting units to create the ingot. The metallurgists spent almost three full shifts producing the giant piece. It was not simply a matter of precisely coordinating melt time, maintaining the required chemical composition, and accounting for all the complex processes raging in the red hot depths of the furnaces. Careful preliminary research, support equipment specially produced for this operation, and, primarily, the experience, skill, and knowledge of dozens of people were required.

Then it was the forger operators' turn.

"This takes a special gift," says shop manager A. M. Kuz'menko. "A forge operator should know metal--his skin should literally sense all the nuances of its behavior during processing. Without exaggerating, I can say that our skilled craftsmen are specialists, unique in their nature. Without them no one in the country would have such ingots to work with."

...Forging continued with intermediate heating for several shifts. And an even longer journey awaited this 60 m, 1200° cast cylinder before it would assume its place in one of the high-capacity power units and begin its service to the public.

Heights that have been conquered are always a threshold for the next. Having proven their powers by this record, the workers at Izhorsk are ready for the next--melting a 500-t ingot!

12809
CSO: 1842/68

RUTHENIUM COMPOUNDS RESEARCH

Moscow PRAVDA in Russian 29 Jan 85 p 3

[Article by N. Zhavoronkov, academician, director of the USSR Academy of Sciences' Institute of General and Inorganic Chemistry]

[Excerpt] The high corrosion resistance and refractoriness of metals of the platinum group and alloys of these metals have made them indispensable in various reactors for obtaining extra-pure substances and materials for radio equipment and electronic technology, manufacturing spinnerets in the production of glass fiber, etc. Ruthenium, too, has found use here, particularly in corrosive environments at heightened temperatures. The use of palladium as a material for contacts in weak-current (radio, telephone, telegraph) equipment eliminates static. In heavy-current technology, contacts made of platinum alloys possess exceptionally high reliability. In short, the advancement of scientific-technical progress has led to such extensive use of platinum metals in technology that the jewelry industry now receives only an insignificant share of the reserves of these metals.

The unique capabilities of ruthenium have not been fully revealed in this connection. The difficulty of extracting this metal from natural raw materials and separating it from other platinum metals has been another factor in this. Consequently, research of compounds formed by ruthenium has always attracted the attention of specialists in our country.

The study of properties of platinum metals, including ruthenium, is being pursued on a broad front at the USSR Academy of Sciences' Institute of General and Inorganic Chemistry imeni Kurnakov (IONKH) -- one of the most important coordination-chemistry research centers in our country. The work of this institute's associates in the field of coordination chemistry of platinum metals is marked by major achievements. But I should now like to devote particular attention to the institute's research of oxide compounds of ruthenium.

Oxide compounds of ruthenium, rhodium, iridium, osmium and other metals of the platinum group possess a unique combination of physical and chemical properties: inertness to oxidizing and reducing agents, thermal stability, wear resistance, and a wide range of electrical conductances depending on their content. These remarkable properties have made it possible to develop titanium electrodes (anodes) with an inert surface coating made of ruthenium oxides.

A regularity involved in changes of the electrical conductivity of dioxides of platinum metals and of base alkali metals has been discovered and a connection between this regularity and the electron configuration of an ion of the corresponding platinum metal established at IONKH. It has become clear that the value of the specific electrical resistance of such dioxides can change within very wide limits -- by seven to eight orders of magnitude. And this permits the selection of materials with the necessary electrical properties. Thick-film resistors and conductive pastes are indispensable for the production of the most advanced printed microcircuits in the electronics industry. Oxide compounds of ruthenium and other noble metals are among the most important components of these resistors and pastes.

FTD/SNAP
CSO: 1842/96

TECHNICAL PROGRESS LAGS AT SPECIAL STEEL PLANT NOTED

Kiev PRAVDA UKRAINY in Russian 12 Jan 85 p 1

[Article by A. Rekubratskiy, correspondent]

[Abstract] The article consists of three short letters from workers of the Dnepr Special Steel (Dneprospetsstal') Plant regarding results of an assessment of technical progress which was conducted at the plant, and a follow-up commentary by the author, who recently visited the plant.

The author's comments call attention to cases of wastefulness which he found at "Dneprospetsstal'", as well as circumstances which are preventing the plant from fulfilling plans for the introduction of new technology. New Soviet-made and imported equipment not only has not been installed at the plant, but has been left outdoors to rust. The author found also that 4,668 tons of defective slabs had to be remelted in 1984. Lead time for the introduction of new developments is said to be too long in general, and cooperation between the plant and research organizations has not always yielded results. Technology lag in a number of areas is attributed partly to scientists' apparent lack of interest. These areas include environmental protection and the recycling of waste products, particularly the recovery of valuable nonferrous metals from production wastes.

The effect from the plant's introduction of developments of the Ukrainian Scientific Research Institute of Special Steels (UkrNIIspetsstal') reportedly has decreased by more than half since 1981, despite the fact that this institute has expanded its

facilities and staff. A joint research project of "Dneprospetsstal'" and UkrNIIspetsstal' on problems of the quality of metals' surfaces has yielded no tangible results so far, despite the fact that specialists of the plant assign key importance to this topic. The institute has assigned only two staff members to this project. The All-Union Research and Production Association for the Mechanization of Ferrous-Metallurgy Facilities is also criticized in this connection. The drafting of plans for mechanizing an ingot-mold yard at the plant reportedly was delayed for four years by the association.

FTD/SNAP
CSO: 1842/96

ULTRASONIC IMAGING OF MATERIALS' PROPERTIES

Moscow MOSKOVSKAYA PRAVDA in Russian 13 Dec 84 p 2

[Article by T. Yemel'yanova]

[Excerpt] An experimental prototype of an acoustic microscope has begun to operate at the USSR Academy of Sciences' Institute of Chemical Physics.

The arsenal of modern methods for studying the microstructure of various objects is very broad. Each of these methods yields important information on many physical parameters, such as color, transparency, shape and dimensions. But what about an object's mechanical characteristics: density, viscosity, elasticity? Can they be seen? This question would appear surprising at first glance. But it has been answered quite seriously in the biophysical imaging laboratory of the Department of Medical Biophysics of the USSR Academy of Sciences' Institute of Chemical Physics: "They can with ultrasound."

R. G. Mayev, head of this laboratory, fastened a small specimen of a new composite material to a miniature holder. This material was made of polystyrene and polyethylene. It is one of many composites that have been developed at the institute. Instruments were switched on, an ultrasound generator began to operate, and the holder and the specimen began to move smoothly, while at the same time vibrating rapidly in a different direction. Ultrasound does the main job here. It is capable of 'seeing' through practically any object and x-raying, so to speak,

specimens that move under its beam. Special instruments receive acoustic signals that have passed through these specimens, analyze them with the aid of a computer and transform them into video signals. Acoustic portraits of the materials are then drawn on the screen of a video terminal.

Such a picture indicates differences in the density of the material at different places in the specimen. And this means that the material's properties can be analyzed and technologists can derive formulas for correctly producing a desired variant of a composite. Nondestructive testing of the quality of materials which may find extensive applications in microelectronics and materials science is performed in this manner.

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CSO: 1842/96

DETONATION SPRAYING UNIT FOR HARDENING PARTS

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 10 Jan 85 p 1

[Article by V. Shvorina]

[Excerpt] Everything was now in readiness for explosions in the machine shop of the Moscow Automotive Assemblies Plant, which is part of the Automotive Plant imeni Likhachev (ZIL) Production Association. In a few minutes, a detonation complex would be put into operation and a gas gun would begin firing continuously. Automotive parts were the target at which it was to fire.

Efforts to solve the complex and pressing technical problem of lengthening the service life of key automotive parts have been in progress at ZIL for many years.

The task has been successfully accomplished with the aid of scientists of the Scientific Research Institute of Automotive Industry Technology, who were under the direction of Candidate of Technical Sciences Yu. Fed'ko. Explosions had to be harnessed for this purpose. An explosion produced by an electric discharge takes place in the barrel of a gas gun. Molten particles of a powder intended for deposition fly from the barrel, embed themselves in a part and cover it in a tough layer.

The fact that inexpensive and readily available powder materials, such as aluminum oxide, are used for this purpose is very significant for mass production. Another important fact is that the coatings are held by parts that have not been precoated with scarce materials based on nickel or molybdenum. These coatings are suitable not only for cast-iron parts but also for ceramic ones and for parts made of light alloys or aluminum.

Tests have shown that hardening by detonation spraying heightens the durability of automotive assemblies by more than five times. Practically no wear on the housings of water-pump bearings was discovered after 300,000 kilometers had been traveled. These bearings are in one of the assemblies which used to give operators particular trouble.

A comparatively small production section is the working place of the "Korund" -- the name given to the detonation-spraying unit by scientists. The gas gun is enclosed in a metal sound-absorbing case. The only sign that somewhere inside of it, explosions are conscientiously performing the peaceful task of lengthening parts' service life is the muffled sound of blows occurring frequently (three shots a second).

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UDC 669.14.018.44:620.017.3

TRANSFORMATIONS IN ZhS6U HEAT-RESISTANT NICKEL ALLOY TESTED FOR FATIGUE

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 58, No 6, Dec 84 (manuscript received 2 Nov 83; in final form 15 Feb 84) pp 1171-1178

KUSHKIN, S. T., MOROZOVA, G. I., BELYAYEV, M. S., GNEVSHEVA, A. I. and SOROKINA, L. P.

[Abstract] The method of physical and chemical phase analysis, based on electrochemical selective isolation of intermetallides and carbides with subsequent x-ray structural and chemical analysis, is used to determine the number and composition of phases in the γ' phase of a heat-resistant nickel alloy. The method is used to study the complex phase transformations and metallochemical interactions of elements accompanying softening of the ZhS6U alloy as it is fatigue tested to estimate not only the influence of temperature but also the role of stresses. It is found that high-temperature alternate loading facilitates the reaction of γ' phase decomposition to the fractions γ'_1 and γ'_2 which have different compositions, accompanied with the reaction of formation of the carbide M_6C. Softening of the alloy in the area of maximum stress results from an increase in phase transformations, a decrease in the content of the most alloyed γ'_1 fraction and an increase in the content of the γ'_2 fraction, which is rich in γ-forming elements. This results in increased permeability of the γ' phase to dislocations which, along with the preferential formation of plate-like segregations of M_6C in zones of maximum stress, accompanies the process of softening of the alloy. Figures 5; references 7: 4 Russian, 3 Western.
[85-6508]

- END -